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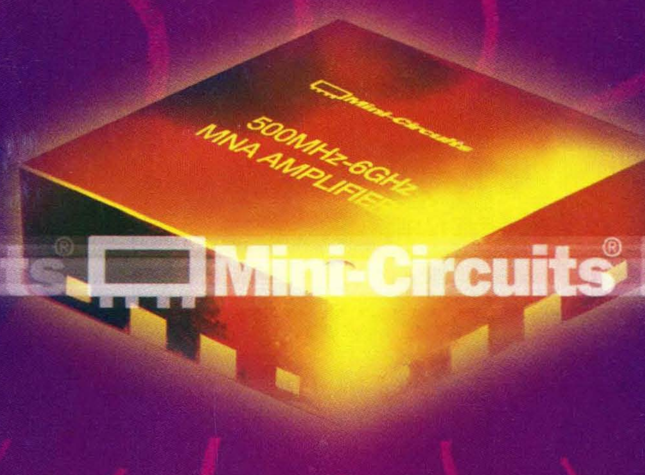
News
Innovations flourish at Wireless Symposium

Design Feature
Coupled-line resonators improve filter performance

Product Technology
High-speed CRU recovers 40 Gb/s

Small Amplifiers Deliver Big Isolation



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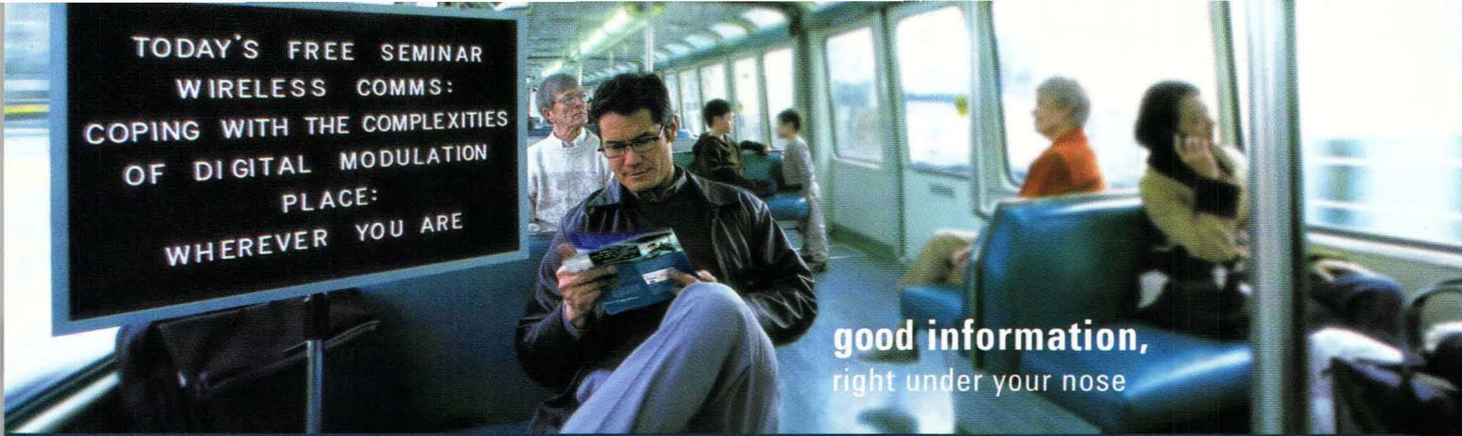
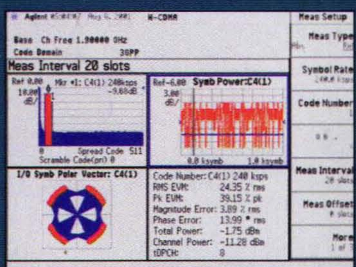
Passive Components Issue



Ah, the wireless dream: Communication anytime, anywhere. Digital modulation makes it all possible, but it also pitches complications into every stage of development—sometimes to the point that the simple goal of just finishing the project can start to seem anything but. So we're working with standards committees and engineers like you to make things easier in areas such as device characterization, receiver sensitivity and modulation quality.

As an example, we've found that two types of EVM measurements can help you improve modulation quality in transmitters. *Composite EVM* checks the quality of a multichannel signal—for any channel configuration—enabling evaluation of W-CDMA downlink signals with different loading.

Meanwhile, *symbol EVM* determines the error rate for a specific code channel at the symbol level, even when multiple codes are present. At low spreading factors (SFs)—and therefore high data rates—chip modulation errors have a significant effect on symbol EVM. However, at high SFs these errors have little effect on symbol EVM. This can help baseband engineers evaluate symbol quality and analyze how specific impairments affect the quality of channels at different data rates.



Symbol EVM measurements over multiple slots can reveal low-frequency problems such as phase noise, which produces a distinctive constellation (lower left).

Sharing this kind of information is just one of the ways Agilent can help you conquer the complexities of digital modulation—and make the dream a bit more of a reality.

For more, please visit www.agilent.com/find/testrf, where you can register for FREE Webcasts and download hints about testing base stations, mobile stations and multiport components.

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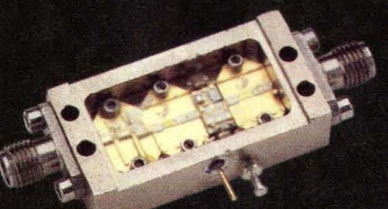
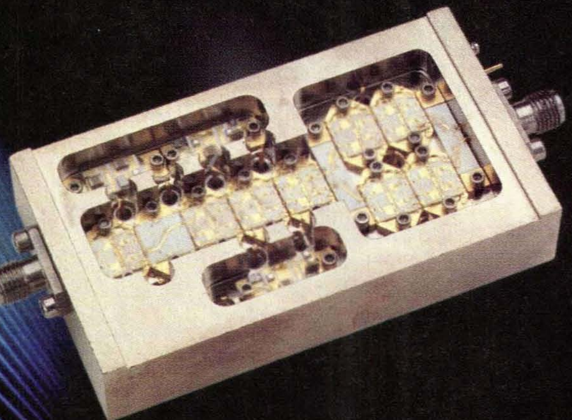


ULTRA BROAD BAND

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA018-203	0.5-18.0	20	5.0	2.5	7	17	2.0:1	250
JCA018-204	0.5-18.0	25	4.0	2.5	10	20	2.0:1	300
JCA218-506	2.0-18.0	35	5.0	2.5	15	25	2.0:1	400
JCA218-507	2.0-18.0	35	5.0	2.5	18	28	2.0:1	450
JCA218-407	2.0-18.0	30	5.0	2.5	21	31	2.0:1	500

MULTI OCTAVE AMPLIFIERS

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA04-403	0.5-4.0	27	5.0	1.5	17	27	2.0:1	550
JCA08-417	0.5-8.0	32	4.5	1.5	17	27	2.0:1	550
JCA28-305	2.0-8.0	22	5.0	1.0	20	30	2.0:1	550
JCA212-603	2.0-12.0	32	5.0	3.0	14	24	2.0:1	550
JCA618-406	6.0-18.0	20	6.0	2.0	25	35	2.0:1	600
JCA618-507	6.0-18.0	25	6.0	2.0	27	37	2.0:1	800

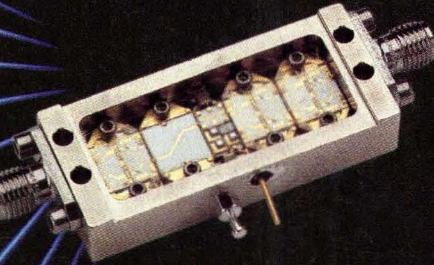


MEDIUM POWER AMPLIFIERS

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA12-P01	1.35-1.85	35	4.0	1.0	33	41	2.0:1	1000
JCA34-P02	3.1-3.5	40	4.5	1.0	37	45	2.0:1	2200
JCA56-P01	5.9-6.4	30	5.0	1.0	34	42	2.0:1	1200
JCA812-P03	8.0-12.0	40	5.0	1.5	33	40	2.0:1	1700
JCA1218-P02	12.0-18.0	22	4.0	2.0	25	35	2.0:1	700

LOW NOISE OCTAVE BAND LNA'S

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA12-3001	1.0-2.0	40	0.8	1.0	10	20	2.0:1	200
JCA24-3001	2.0-4.0	32	1.2	1.0	10	20	2.0:1	200
JCA48-3001	4.0-8.0	40	1.3	1.0	10	20	2.0:1	200
JCA812-3001	8.0-12.0	32	1.8	1.0	10	20	2.0:1	200
JCA1218-800	12.0-18.0	45	2.0	1.0	10	20	2.0:1	250



NARROW BAND LNA'S

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA12-1000	1.2-1.6	25	0.75	0.5	10	20	2.0:1	80
JCA23-302	2.2-2.3	30	0.8	0.5	10	20	2.0:1	80
JCA34-301	3.7-4.2	30	1.0	0.5	10	20	2.0:1	90
JCA56-401	5.4-5.9	40	1.0	0.5	10	20	2.0:1	120
JCA78-300	7.25-7.75	27	1.2	0.5	13	23	2.0:1	120
JCA910-3000	9.0-9.5	25	1.2	0.5	13	23	1.5:1	150
JCA910-3001	9.5-10.0	25	1.2	0.5	13	23	1.5:1	150
JCA1112-3000	11.7-12.2	27	1.1	0.5	13	23	1.5:1	150
JCA1213-3001	12.2-12.7	25	1.1	0.5	10	20	2.0:1	200
JCA1415-3001	14.4-15.4	35	1.4	1.0	14	24	2.0:1	200
JCA1819-3001	18.1-18.6	25	1.8	0.5	10	20	2.0:1	200
JCA2021-3001	20.2-21.2	25	2.0	0.5	10	20	2.0:1	200

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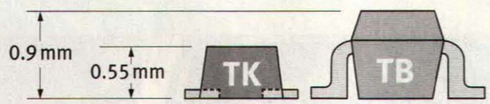

GaAs MMIC SPDT Switches

Part Number	Insertion Loss @ 1.0 GHz	P_{IN} Power Handling	Control Voltage	Package	100K Price	Description
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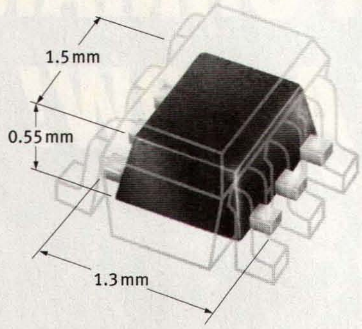
UPG2009TB	0.25 dB	+34 dBm @ 0.1 dB	2.8 V	TB	78¢	*High Power, No Compromises*
UPG2006TB	0.35 dB	+20 dBm @ 1.0 dB	1.8 V	TB	54¢	*Low Voltage, Great Specs*
UPG158TB	0.3 dB	+25 dBm @ 0.1 dB	3 V	TB	39¢	*Good Specs, Great Price*
UPG152TA	0.4 dB	+30 dBm @ 1.0 dB	3 V	TA	29¢	*Low Cost 3V Switch*

Applications for CEL's NEC switches include: Bluetooth, PCMCIA Cards, Cordless Phones, Digital Cellular, PCS, WLAN, and WLL.



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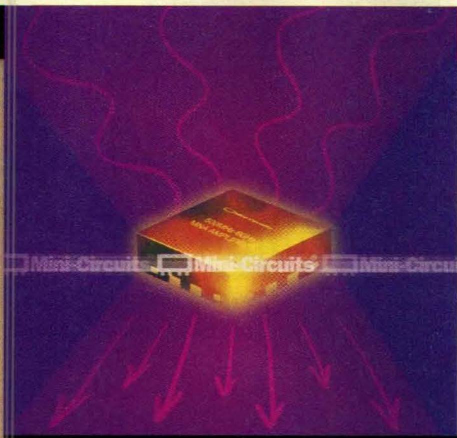

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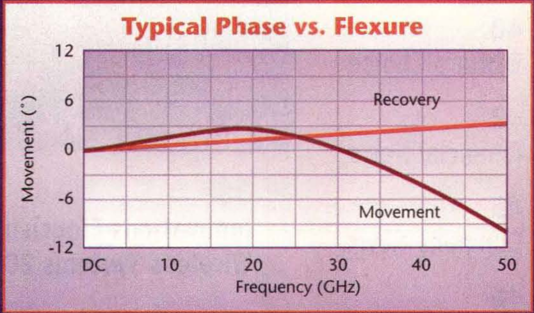

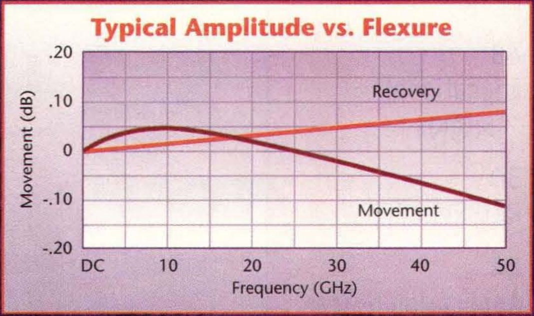

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150T-15	0-15/15		4
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150T-62	0-62/2		5
150T-70	0-70/10		3
150T-75	0-75/5		4
150T-110	0-110/10		4
151T-11	0-11/1	dc-4 GHz	4
151T-15	0-15/15		4
151T-31	0-31/1		5
151T-62	0-62/2		5
151T-70	0-70/10		3
151T-75	0-75/5		4
151-110	0-110/10		4
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152T-15	0-15/1		4
152T-55	0-55/5		4
152T-90	0-90/10		4
3200T-1	0-127/1	dc-2*	8
3200T-2	0-63.75/0.25		8
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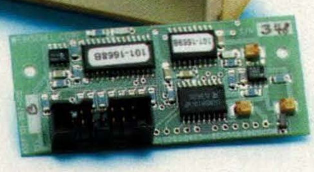

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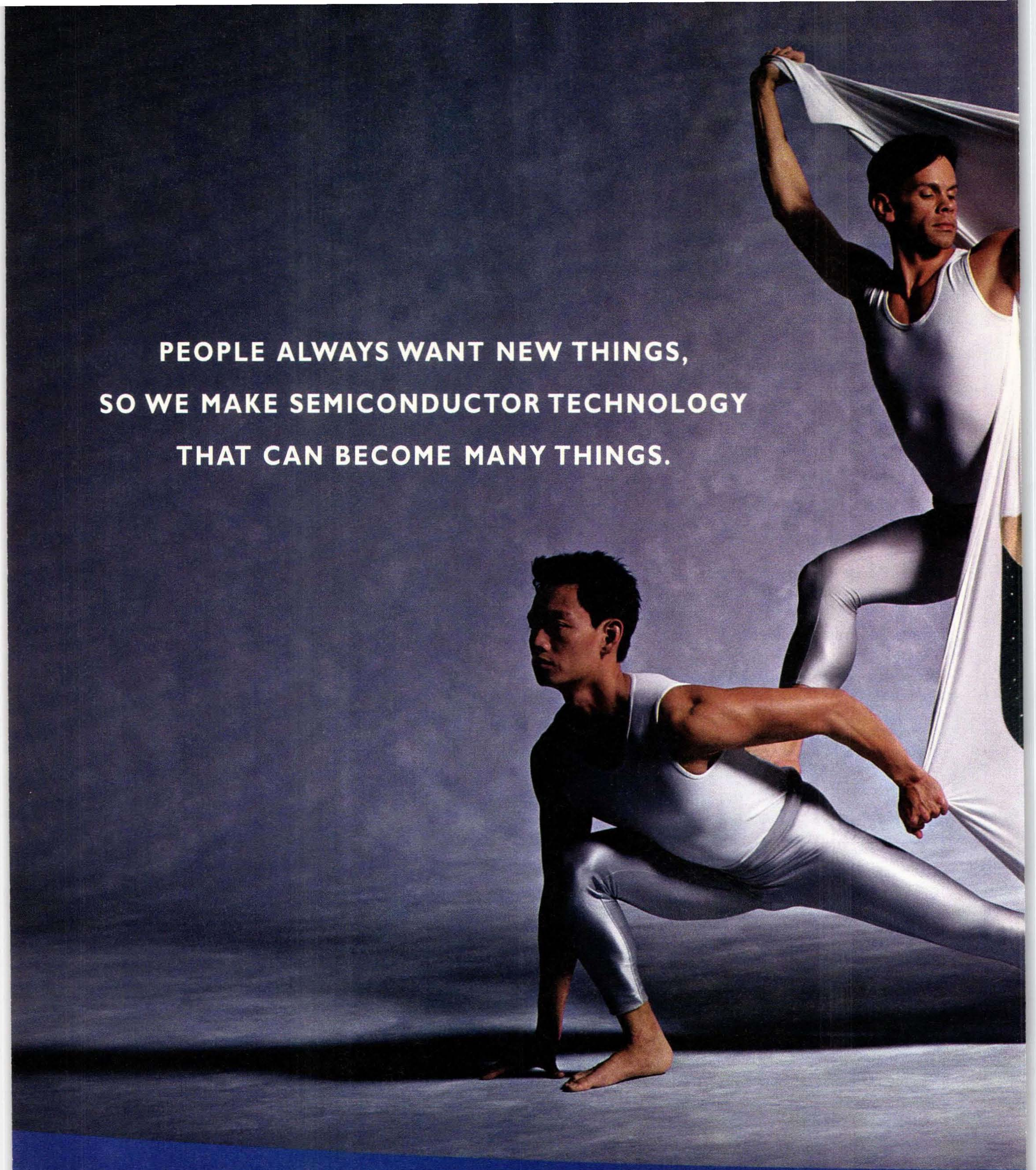

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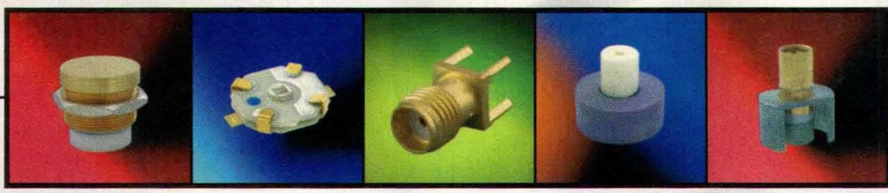

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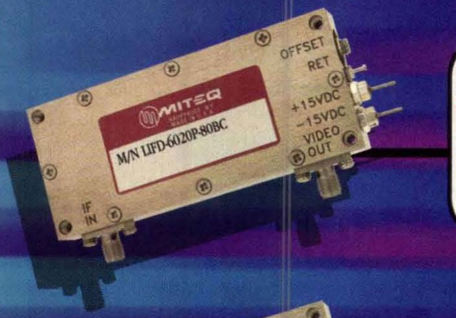
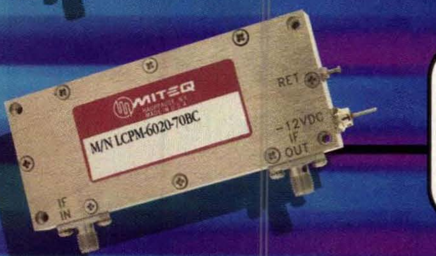


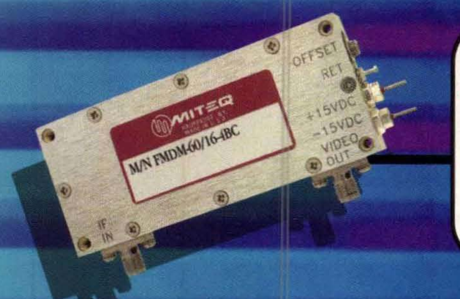
MODEL NUMBER	CENTER FREQUENCY (MHz)	DYNAMIC RANGE (dBm, Min.)	LINEARITY (dB, Max.)	RISE TIME (ns, Max.)	LOGGING SLOPE INTO 93 OHMS (mV/dB, Typ.)
LIFD-3010P-80BC	30	-80 to 0	±0.5	100	25
LIFD-6020P-80BC	60	-80 to 0	±0.5	50	25
LIFD-7030P-80BC	70	-80 to 0	±0.5	30	25
LIFD-16040-80BC	160	-80 to 0	±1.0	30	25
LIFD-300100-70BC	300	-70 to 0	±1.0	20	15

CONSTANT PHASE LIMITING AMPLIFIERS



MODEL NUMBER	CENTER FREQUENCY (MHz)	DYNAMIC RANGE (dB, Min.)	OUTPUT POWER (dBm, Min.)	POWER VARIATION (dB, Max.)	PHASE VARIATION (Max.)
LCPM-3010-70BC	30	-70 to 0	10	±0.5	±3°
LCPM-6020-70BC	60	-70 to 0	10	±0.5	±3°
LCPM-7030-70AC	70	-65 to 5	10	±0.5	±5°
LCPM-16040-70BC	160	-65 to 5	10	±1.0	±3°

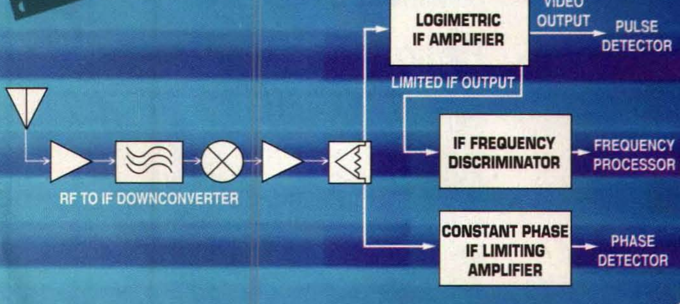
FREQUENCY DISCRIMINATORS



MODEL NUMBER	CENTER FREQUENCY (MHz)	LINEAR BANDWIDTH (MHz, Min.)	SENSITIVITY (mV/MHz, Typ.)	LINEARITY (%, Max.)	RISE TIME (ns, Max.)
FMDM-30/6-3BC	30	6	1000	±3	120
FMDM-60/16-4BC	60	16	250	±3	90
FMDM-70/36-10AC	70	36	50	±2	50
FMDM-160/35-15BC	160	35	100	±2	30
FMDM-160/50-15AC	160	50	40	±2	25
FMDM-750/150-20BC	750	150	20	±3	20
FMDM-1000/300-50AC	1000	300	10	±5	7

AUTOMATIC GAIN CONTROL LINEAR AMPLIFIERS

MODEL NUMBER	CENTER FREQUENCY (MHz)	BANDWIDTH (-3 dB) (MHz, Min.)	DYNAMIC RANGE (dBm, Min.)	OUTPUT POWER (dBm, Min.)	POWER VARIATION (dB, Max.)
AGC-7-10.7/4AC	10.7	4	-70 to 0	10	±0.5
AGC-7-21.4/10AC	21.4	10	-70 to 0	10	±0.5
AGC-5-70/30AC	70	30	-50 to 0	-4	±0.5
AGC-7-160/30AC	160	30	-70 to 0	8	±1.5
AGC-7-300/400AC	300	400	-65 to 0	3	±1.0



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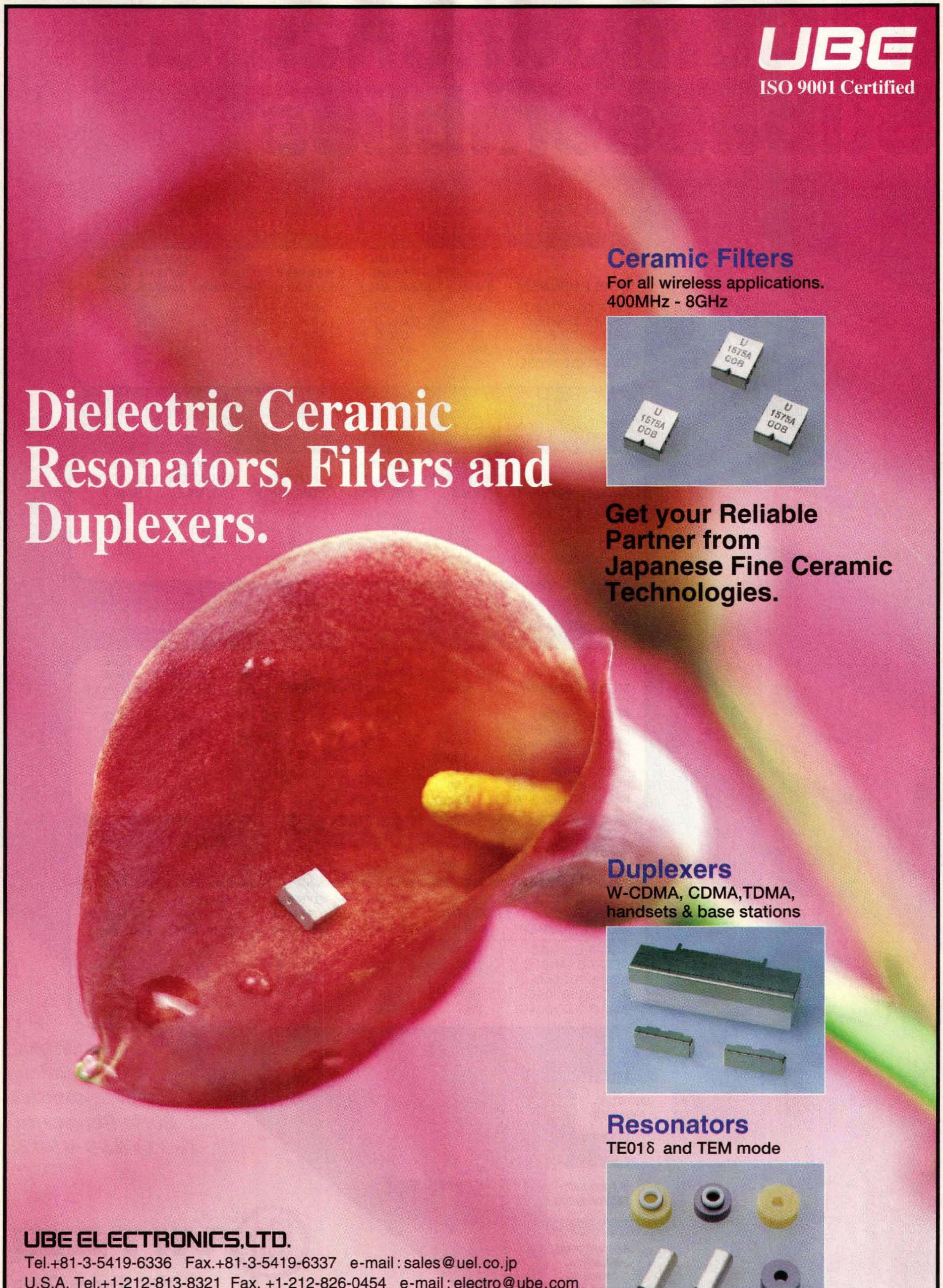

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Future Of Telecom

▶▶I HAVE TO say that I disagree with October's Financial Lead, "War Clouds The Telecom Future" (p. 46). I actually think this article serves as an unnecessary catalyst to further depress the telecommunications industry.

While everyone understands that the nation still mourns its losses, it is also vital for business to go on. This does not really mean "as usual," but certainly with robust confidence. I would like to briefly point out certain developments that should indicate a strengthening of telecom-related opportunities.

It may seem ironic that after September 11th, I am seeing new positive opportunities, but that is business. Three out of several massive industry sectors that people vitally need are food, finance, and transportation. With the exception of air transportation, these industries continue to go on and are strong. Ground transportation may, in fact, be able to take advantage of the air industry's plight.

The third paragraph of October's Financial Lead mainly looks at the fiber-optic side of the industry. We can all agree that even with fiber optics by itself, this industry is depressed and may begin to recover later in the year or during 2003. Even here, the recovery may be helped as the (admittedly massive) available bandwidth gets increasingly squeezed and more fibers become lit. The current use of video conferencing and high-speed Internet could also boost the economy in 2002. Another big current and future market driver is "last-mile links"—either free-space optical or radio wireless city telecom links to high-bandwidth optical MANs at street level.

Also, immediately after September 11th, sales of cell-phone handsets began to increase. While this has immediate and positive implications for the industry, I believe that it will lead to an earlier-than-expected takeup of 3G with the numbers of people who have the experience and expectations from using the medium. Other factors, such as VC and radio wireless last-mile links, provide further tangible market drivers for RF and microwave technology.

If those of us in Western democracies get into the slough of negative thinking (e.g., the telecom sector is getting further depressed and "this will make things much worse...") this thinking will indeed make things even worse (i.e., we will be talking and thinking ourselves into a true slump of hitherto unprecedented dimensions). However, if we carefully and calmly look at what is already happening, we can identify solid and strong market drivers for near-future RF and microwave product requirements.

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Engalco

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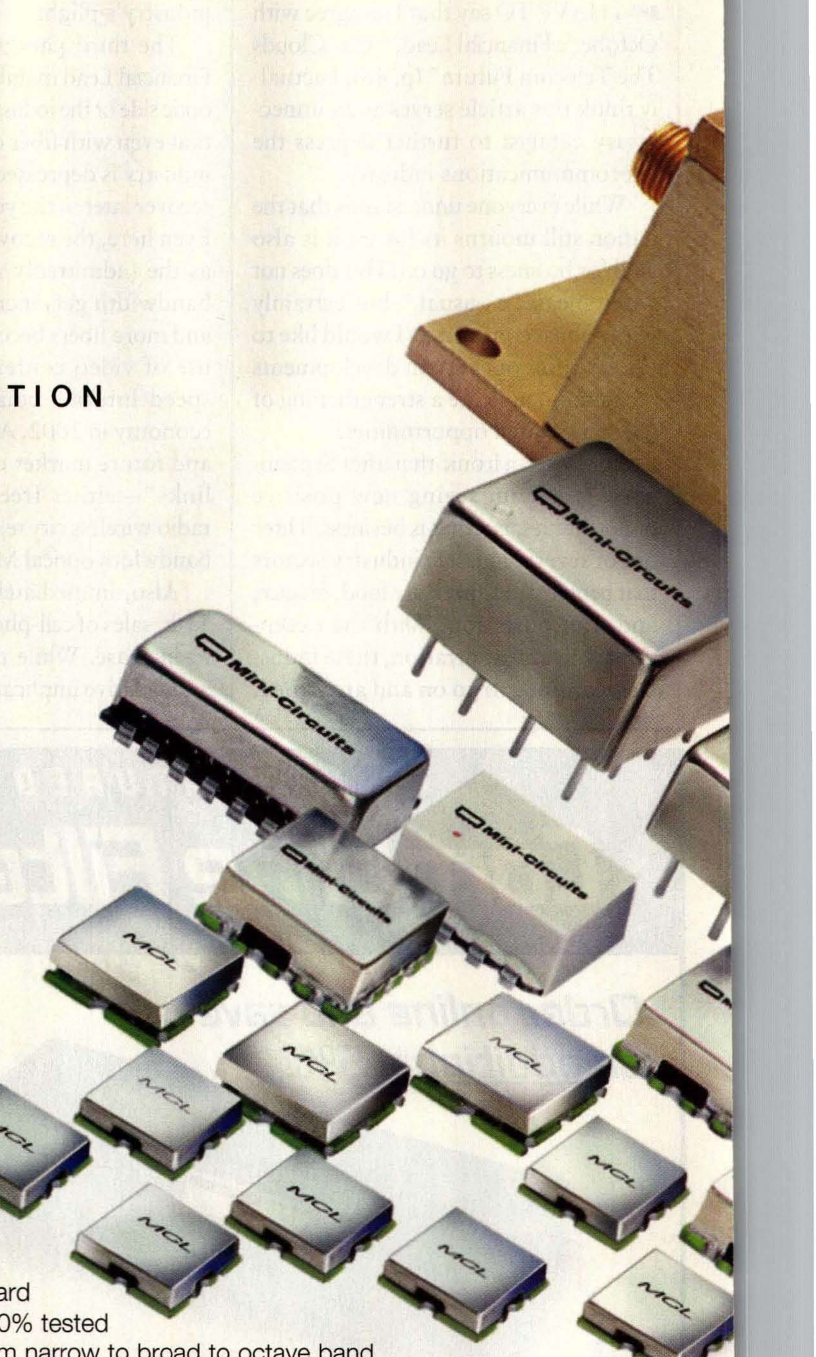

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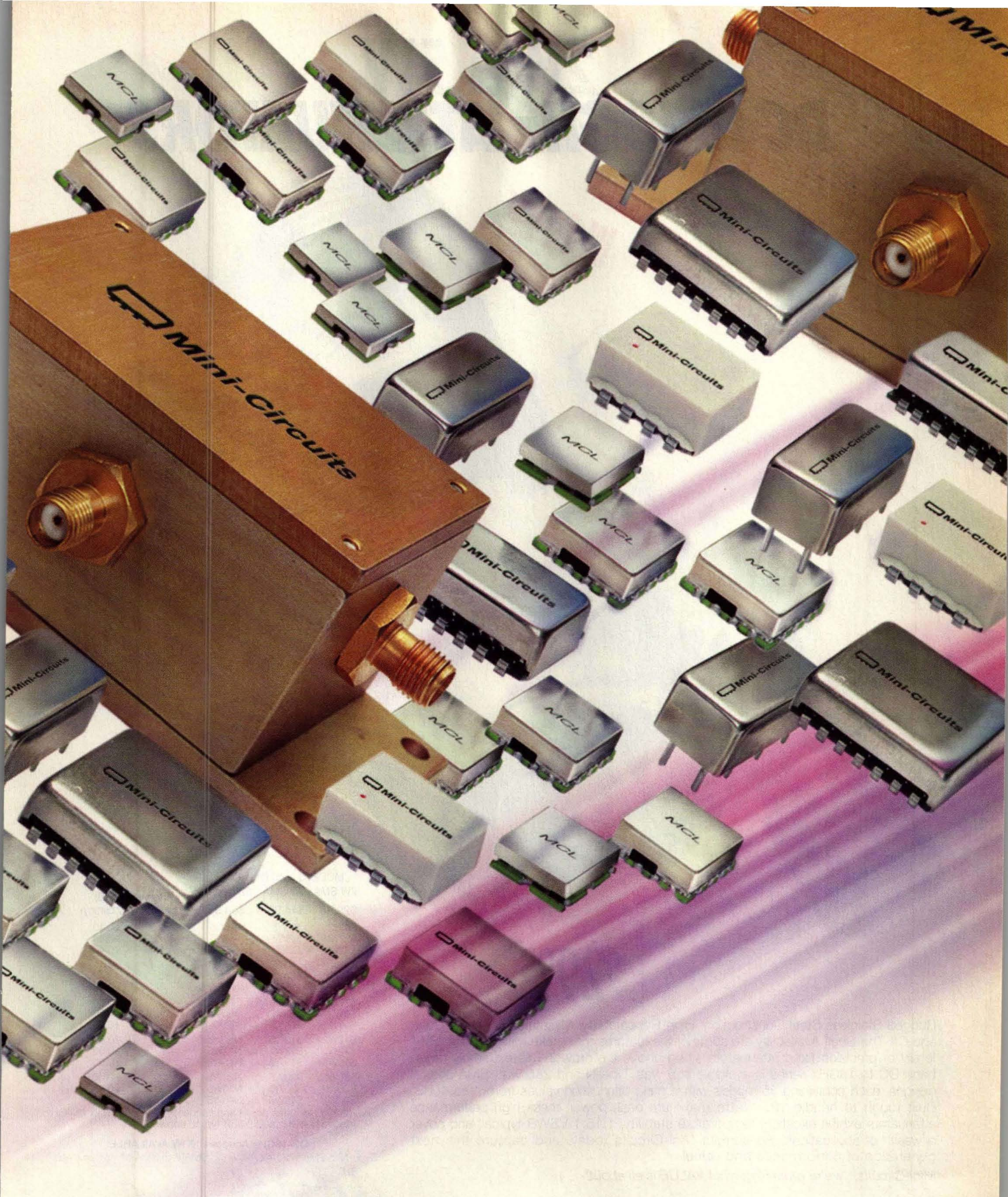

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S5W2	S5W5	N5W5	5	±0.40
S6W2	S6W5	N6W5	6	±0.40
S7W2	S7W5	N7W5	7	±0.60
S8W2	S8W5	N8W5	8	±0.60
S9W2	S9W5	N9W5	9	±0.60
S10W2	S10W5	N10W5	10	±0.60
S12W2	S12W5	N12W5	12	±0.60
S15W2	S15W5	N15W5	15	±0.60
S20W2	S20W5	N20W5	20	±0.60
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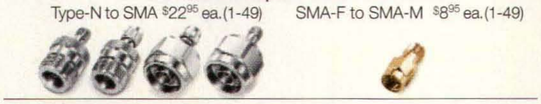

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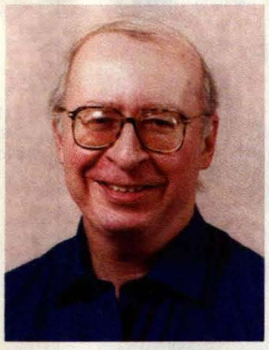
Musings On The Wireless Show



It began 10 years ago, almost as an experiment. The high-frequency industry had been reeling from cutbacks in its traditional military business, and was almost desperate for any new opportunities. In some parts of the industry, the word "wireless" kept creeping into conversations, as if wireless could ever replace those lost military markets. The experiment—to start a show known as the Wireless Symposium & Exhibition and bring all of these discussions of wireless technology under one roof for a few days—helped to jump-start what would become the high-frequency industry's major market for the 10 years that would follow.

The wireless industry has mirrored the cyclical nature of the electronics industry, with yesterday's hot markets becoming today's cold spots.

That first show, held in February 1993 in the San Jose Convention Center, featured a wide range of applications ranging from automotive systems to WLANs. In truth, since the wireless industry was in its infancy, the show's organizers were aware of the different application areas, but really had no idea which market segments would prove to be the shining stars. As it has grown, the wireless industry has mirrored the cyclical nature of the overall electronics industry, with yesterday's hot markets becoming today's cold spots.

Two of the technical areas of interest in that first Wireless Symposium & Exhibition were automotive collision-avoidance systems and RFID. The two areas represent two technological extremes, with automotive relying on traditionally expensive and finicky millimeter-wave components, while RFID applications could be implemented with low-cost Tx ICs. It is not surprising that RFID devices have sold in the millions, while millimeter-wave warning systems are still only available in high-end automobiles.

Cellular applications quickly became the mainstay of many companies pursuing wireless business, with technology rapidly progressing from simple analog systems to more-sophisticated TDMA and CDMA systems. Major investors even supported attempts at LEOS versions of cellular systems. But while these systems represented the pinnacle of wireless technology, they could not compete with terrestrial cellular systems.

The wireless show is now known as Wireless Systems 2002, and the cellular activity was quiet. But the WLAN folks were busy at 2.4 and 5 GHz. Some companies, such as Intersil, even demonstrated working products. Next year, who knows? Maybe Bluetooth will finally grab the spotlight.

Jack Browne

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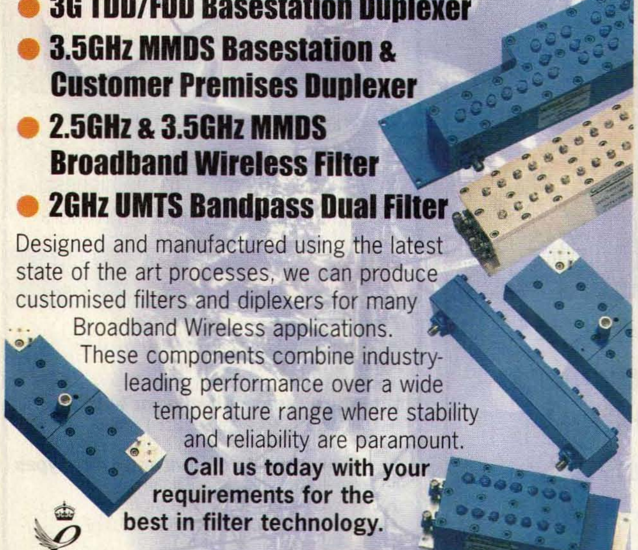

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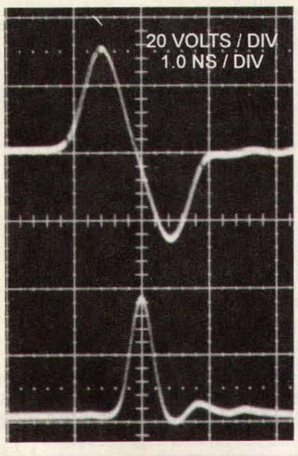

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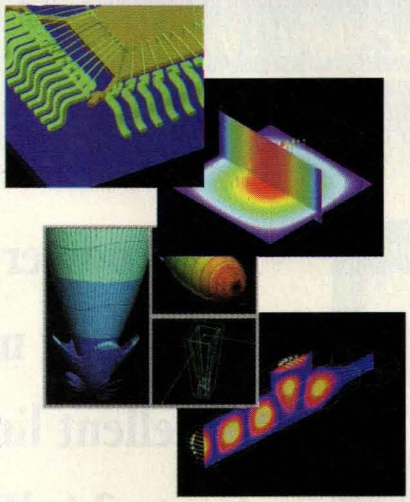

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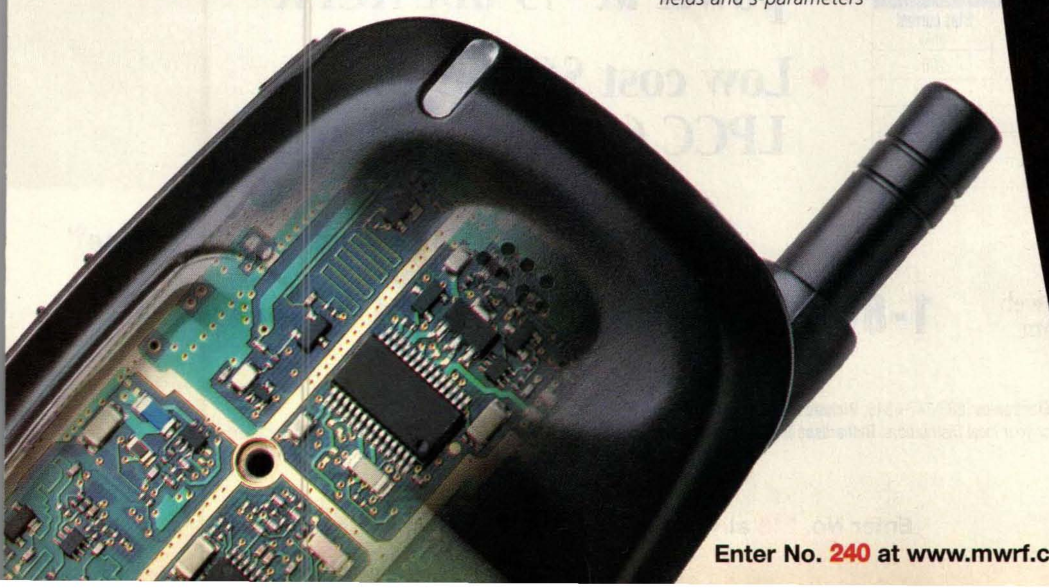

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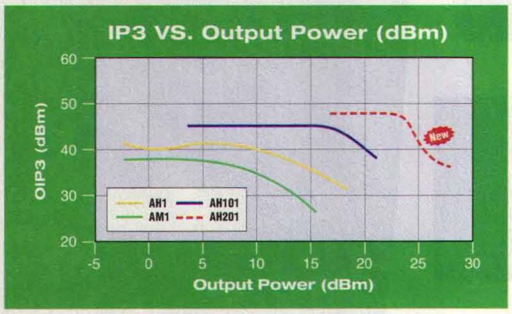

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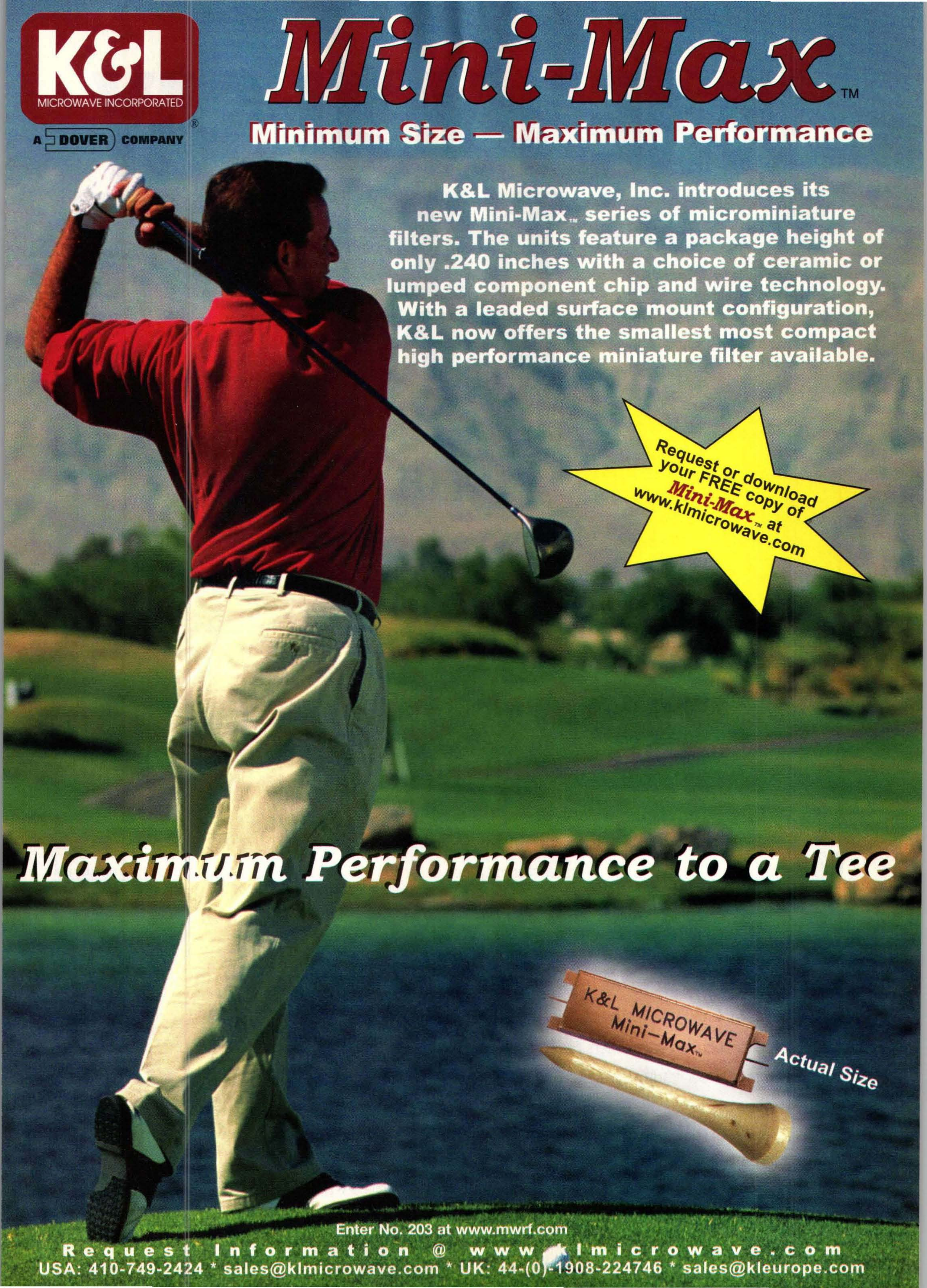
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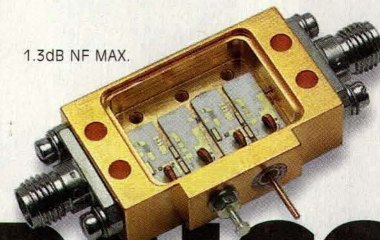

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Parameter	Min	Typ	Max	Unit	Notes
Frequency of Operation	0.1		2.3	GHz	
Small Signal Gain	25	26		DB	
VSWR In/Out		1.35/1	1/4/1		
Isolation (S12)	35	40		DB	
Pout 1db Comp.	9	10		DBm	
Noise Figure		1.2	1.3	DB	
DC Current @ +5Vdc		120	140	mA	
Unit-To-Unit					
Gain Tracking	-1		+1	DB	Set or 2 units or more
Phase Tracking	-1		+1	Degrees	Set of 2 units or more
Package Size					1.21" x 0.67" x 0.37 SMA-connectorized

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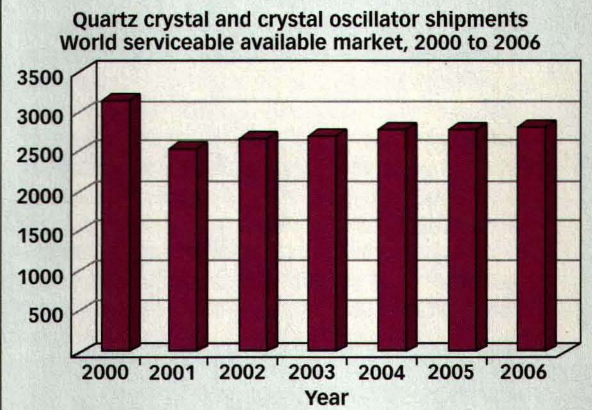
the front end

News items from the communications arena.

Market Reality Changes For Crystal And Oscillator Vendors

OYSTER BAY, NY—"The crystal-timing market reached an unsustainable high point in 2000 due to buildout of communications infrastructure and continued growth in traditional handset and PC markets," says Andy Fuertes, the director of research at Allied Business Intelligence, Inc. (ABI) and author of the ABI report, "Oscillators World Markets, Changing Dynamics, New Market Drivers and Competitive Landscape." Fuertes continues, "However, 2001 ushered in a series of firsts that changed that, including the first-ever declines in handset and PC shipments, and a sweeping financial crisis in telecommunications. The result was a decline in market value from $3.1 billion in 2000 to $2.5 billion in 2001" **(see figure).**



Source: Allied Business Intelligence, Inc.

The steepest declines occurred in the telecommunications market pushing down the market value of telecom-dependent voltage-controlled crystal oscillators (VCXOs) by 25 percent. VCXOs also endured encroachment by replacement technologies such as timing-recovery modules which extract a timing reference from a data-communications stream and eliminate the need for a VCXO. The impact of these silicon (Si) devices has been mainly in the Synchronous Optical Network (SONET) realm, but expansion overtures are ominous.

Disruptive technologies such as Si timing devices have put greater pressure on existing oscillator vendors to partner or combine with existing Si houses.

Public WLAN Services In US Will Reap $3 Billion By 2007

CAMBRIDGE, ENGLAND—Mobile Internet access through wireless local-area networks (WLANs) generated considerable interest as it became available in more 'hot spots' during 2001, and growth is expected to continue. Networks are being deployed and a wide range of access devices are becoming available. With widespread industry backing, the 802.11b standard is now gaining pre-eminence as the technology for service delivery. Security concerns are being addressed by WLAN operators, who are now being supported by specialist technical enablers. *Public Wireless LAN Access: US Market Forecasts 2002-2007*, a report from Analysys Research, states that annual revenue from WLAN services in the US will reach approximately $3 billion by 2007, 20 percent of which will be generated by consumers.

However, for the public WLAN market to develop successfully, four critical uncertainties remain to be addressed: establishment of widespread end-user demand, development of attractive service propositions, increased coverage of hot-spot locations, and improved interfaces for users to locate hot spots.

The establishment of widespread end-user demand is unlikely to be a problem. First movers, including MobilStar and Wayport in the US, are successfully targeting the business traveller, in particular the professional whose time spent travelling continues to increase, along with the pressure on them to use this time productively. In consumer-driven markets, data demand is likely to be strong, as suggested by the success of SMS in Europe.

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"ADSL subscriptions in Europe outstripped those for cable-modem services for the first time in 2001."

ADSL Dominates European Broadband Market

LONDON, ENGLAND—Although the growth of residential broadband is very slow in the United Kingdom (see "Broadband Penetration Is Low In The United Kingdom," March 2002, p. 24), the technology has begun to make inroads in mainland Europe. Asymmetric-digital-subscriber-line (ADSL) subscriptions in Europe outstripped those for cable-modem services for the first time in 2001. A report from the Yankee group, entitled, "European Residential Broadband Takes Off," presents a detailed forecast for consumer broadband in 15 Western European markets. Highlights of the report include predictions that by 2006: Broadband will penetrate 20 percent of all households, serving over 31 million customers; The value of the broadband-access market will reach 11.2 billion euros ($9.4 billion); and ADSL will account for 80 percent of total consumer broadband-access revenue.

"Projected growth depends upon a number of key drivers," states Jonathan Doran, the report's author. These drivers include the continued rollout of DSL by incumbent telecommunications companies and the aggressive response of cable operators in developing broadband services to compete directly with ADSL. Other major growth boosters will include competitive pricing, greater availability of self-installation packages, and wider government support of national broadband initiatives.

Several remaining factors could also constrain the potential development of residential broadband. Availability may be hampered by cutbacks to roll-out plans in light of growing financial difficulties. A lack of real competition following the failure of local-loop unbundling may keep prices high, deterring large numbers of potential customers from adopting broadband. "Most significantly," says Doran, "the industry has yet to convince consumers of the broadband value proposition, given the wide availability of low-cost narrowband services and the continuing dearth of compelling broadband content."

Alliance Will Accelerate Electronic Product Development

SAN JOSE AND PALO ALTO, CA—Cadence Design Systems, Inc. and Agilent Technologies, Inc. have announced a far-reaching, multiyear technology alliance that is expected to accelerate electronic product development in the communications industry.

Through this alliance, the firms are expected to develop and market complete integrated solutions to speed the design of integrated circuits (ICs) for the wireless and wire-line communications industries.

"This is the beginning of an alliance with Agilent, with its best-in-class RF technology for electronics design, that will produce superior solutions to accelerate time to market for customers," says Ray Bingham, president and CEO of Cadence. "By pooling the expertise and resources of two industry leaders, we can deliver even greater value to our mutual customers."

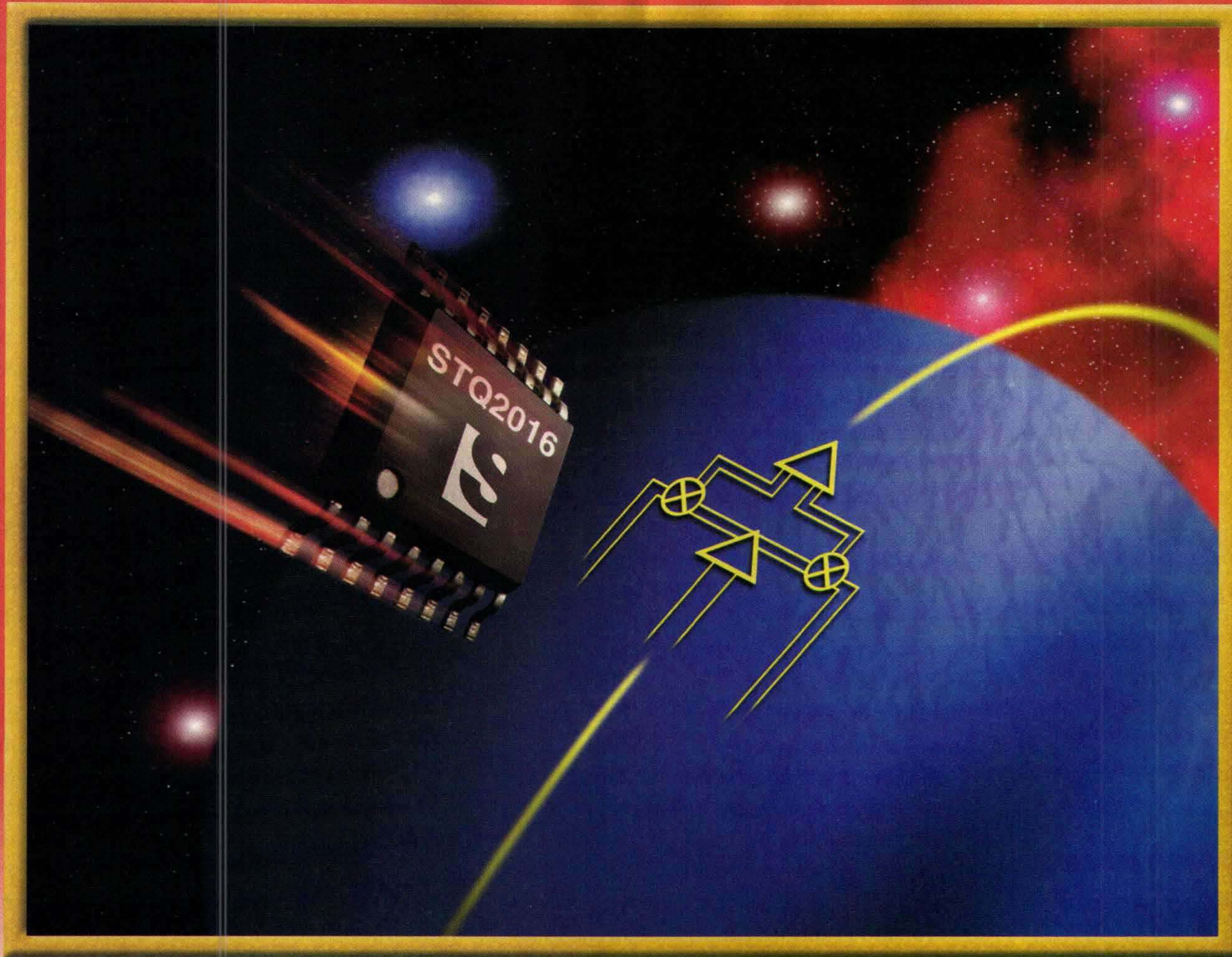
In the first phase of the alliance, the companies will jointly develop a more integrated design flow for large-scale RF/mixed-signal (RF/MS) ICs used in wireless appliances and high-speed networking equipment. By eliminating the need for electronics companies to spend time integrating separate electronic-design technologies, a jointly developed RF/MS IC design flow is expected to substantially shorten product-development time, lower design costs, and enable companies to focus on creating innovative products.

Firm Unifies The Name For All Of Its IC Operations

IRVINE, CA—Microsemi Corp. has announced an official name change for its integrated-circuit (IC) businesses located in the California cities of Carlsbad, Garden Grove, Irvine, and Los Angeles.

The new name, Microsemi Integrated Products, provides a uniform identity for circuit-design centers in Carlsbad and Los Angeles, previously known as Microsemi MicroPower and Micro WaveSys, respectively, for the analog/mixed-signal design and manufacturing operations of Linfinity Microelectronics in Garden Grove, and for the product-development center in Irvine.

"Our four operations have been working closely together in product and manufacturing development for many months now, so it makes very good sense to create a single identity that can umbrella our similar intellectual properties," says Kelly Jones, vice president and general manager at Garden Grove.



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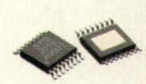

TSSOP16 with ground pad, *actual size!*

Model	Frequency Range (MHz)	Output P1dB (dBm)	Carrier Feedthrough (dBm)	Sideband Suppression (dB)	IM3 Suppression (dB)	Broadband Noise Floor (dBm/Hz)	LO Drive Level (dBm)	Phase Error (deg)	Amplitude Balance (dB)
STQ-2016*	700–2500	+3	-40	40	65	-155	-5	±0.5	±0.05
STQ-3016†	2500–4000	+1	-40	33	50	-153	-6	±2.5	±0.10

*f_{LO} = 2,000 MHz; †f_{LO} = 3,500 MHz

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Can VoIP Move To The Next Level?

STERLING, VA—For Voice over Internet Protocol (VoIP) to be successful, service providers need to stop protecting their legacy offerings and position VoIP as *the* solution to improve an enterprise's business processes by leveraging the technology's efficiencies in the same way that the personal computer (PC) and the Internet did, says Counse Broders, principal analyst for Internet Services at Current Analysis.

Broders advocates a more aggressive approach and advises service providers to bundle and market handsets and switches, combine them with transport and voice applications to make voice Internet communications an appealing investment for enterprise customers. Those first to command this combination can grab the market leadership needed to take VoIP to the next level.

> **"R&D dollars need to be allocated now toward establishing the beach head for future voice applications."**

In his Current Analysis report, *The Seeds of the VoIP Future*, Broders makes the following vendor recommendations:

1. Players should look to capitalize on their data centers with hosted telephony solutions that can gain a lead in this new market, establish market share, and tap clients traditionally served by Centrex-type solutions.
2. Vendors should take steps now to set up partnerships that can ensure hardware for local users [handsets, customer premises equipment (CPE), and switches], that can, in turn, be coupled with transport features to offer a one-stop shop solution. A simple package that lays this out for clients goes a long way toward making a customer's life simpler.
3. Research-and-development (R&D) dollars need to be allocated now toward establishing the beach head for future voice applications. Since bureaucracy is a great way to slow down this effort, larger vendors should encourage startups that can speed solutions to market that can, in turn, leverage the size of a telephony network.
4. Vendors need a solid integration plan and client support to ensure seamless transition from traditional voice services to VoIP services. Training should be implemented with sales staff to better understand this difference and to develop the skill set to succeed with it.

Kudos

At the recent Winter Olympics in Salt Lake City, UT, Stitch Networks made it possible for 150 Coca-Cola vending machines to house TI-RFID readers from Texas Instruments. Because of this, 5500 athletes, coaches, and officials were provided with complementary beverages by simply waving their Coke bottle-shaped keyring tags. The devices were used inside the Olympic Village, at training venues, and in athlete lounges. Each Coke bottle transponder contained a TI-RFID computer chip, which held a unique preprogrammed identification number. When athletes approached an RFID-equipped vending machine, they presented their key ring to the RFID reader and instantly received beverages without having to use cash. The system recognized the signal, authorized the transaction, and provided the athletes with free soda courtesy of Coca-Cola. The TI-RFID technology is also being used by more than 6 million ExxonMobil Speedpass™ customers...Silicon Wave, Inc. has been certified to the international quality standard ISO9001...The tower division of Andrew Corp.'s South African subsidiary (Andrew Satcom Africa) has received the South African President's Award for Export Achievement in the Information and Communication Technology category...KONEXX has been awarded US Patent No. 6,282,271 for ModemMinder™, a compact plug-in device that protects analog modems from hazardous higher voltage encountered on digital private-branch-exchange (PBX) telephone lines in hotels and office buildings...Intermec Technologies Corp. was named a Microsoft Windows Embedded Partner of the Year in the original-equipment-manufacturer (OEM) category at the Windows Embedded Partner Summit, part of the Windows Embedded Developers Conference, which was held in late November in Las Vegas, NV. Intermec was selected for its commitment to incorporating Windows CE 3.0 into its range of handheld computers...Washington Laboratories Ltd. (WLL) has received notification from the Underwriters' Laboratories (UL) that they have been approved under the UL Engineering CAP. As a UL Certified Engineering Agency, WLL can now perform UL testing without engineer-witnessing from a UL representative. WLL is currently approved for testing to UL60950 and UL1950 and additional standards will be added to the approval designation over time. Previously, UL had to witness every test. Now, WLL can schedule clients without being held to witnessing timing. MRF

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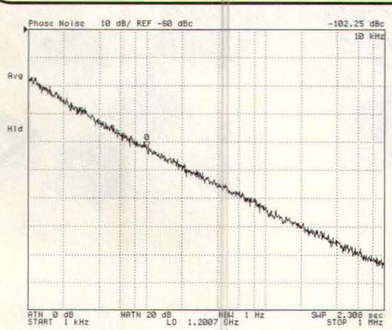
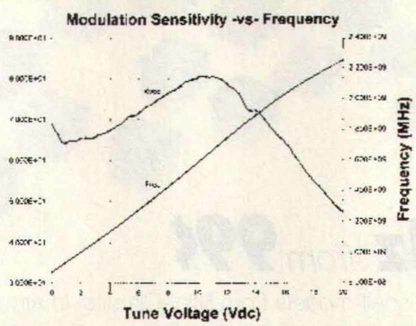
VCO790-1500T	1000-2000	0.0 - 20.0	-98 dBc/Hz	+5 V	+2 dBm	0.5 x 0.5 x 0.18 in.
VCO790-2300T	2100-2500	1.0 - 4.0	-89 dBc/Hz	+5 V	+3 dBm	0.5 x 0.5 x 0.18 in.
VCO793-600T	400-800	0.0 - 20.0	-104 dBc/Hz	+12 V	+7 dBm	0.5 x 0.5 x 0.18 in.
VCO793-1500T	**1000-2000**	**0.0 - 20.0**	**-99 dBc/Hz**	**+12 V**	**+7 dBm**	**0.5 x 0.5 x 0.18 in.**

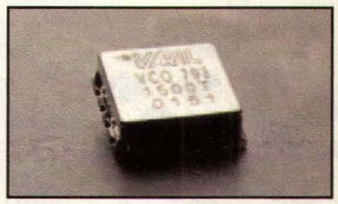
Actual data for VCO793-1500T

Phase noise from HP3852 for 1000-2000 MHz VCO



Tuning Sensitivity from HP3852 for 1000-2000 MHz VCO





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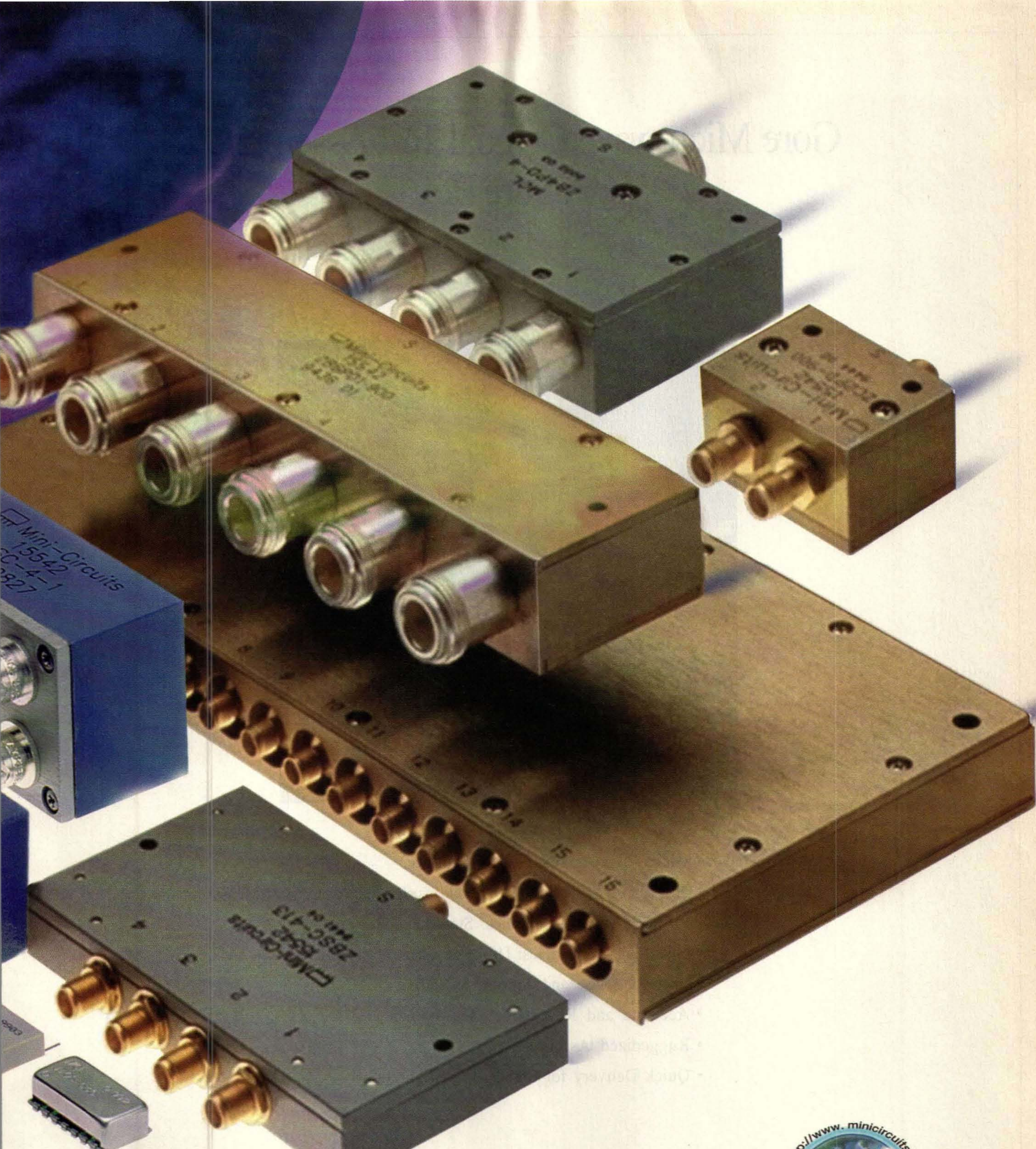

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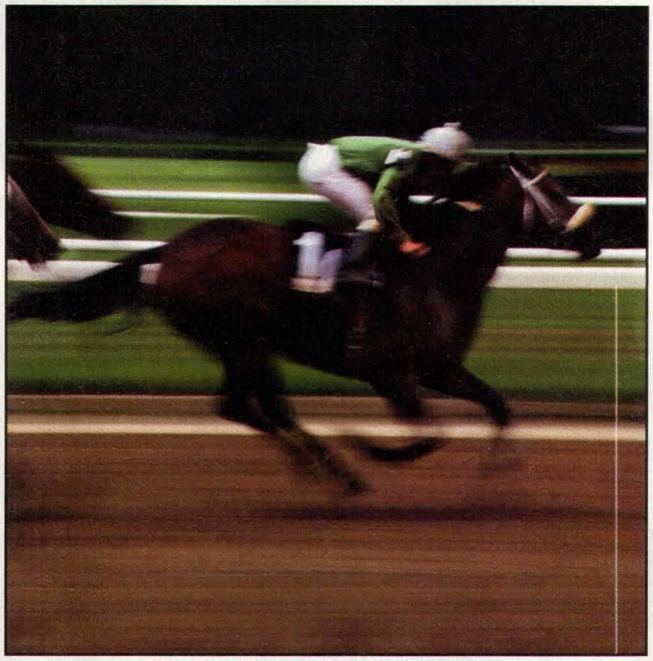

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NEWS

Innovations Flourish At Wireless Systems 2002

Despite a struggling economy, the 10th Anniversary of the Wireless Systems 2002 Conference and Exhibition signalled the launch of a number of new products and technologies.

Advances in technology and product development are often announced at key industry events, and the Wireless Systems 2002 was one of the first of these opportunities for the wireless industry to "make some noise." Held February 25-28, 2002 in the San Jose Convention Center (San Jose, CA), the conference and exhibition (formerly known as the Wireless Symposium & Exhibition) celebrated its 10th year with a host of key product and technology launches as the industry hoped for renewed business interest throughout diverse application areas of wireless technology.

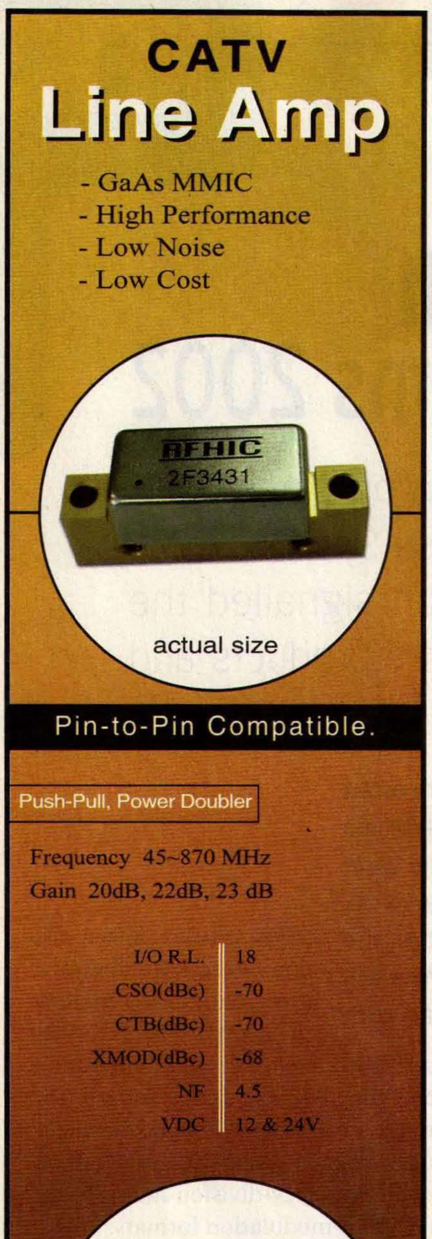
PETER STAVENICK
Managing Editor

JACK BROWNE
Publisher/Editor

If activity within the technical sessions and the exhibit floor is any indication, one of the hottest areas for wireless business is now wireless local-area networks (WLANs). A longtime leader in that technology, Intersil (Palm Bay, FL), made waves with its proven IEEE 802.11b 11-Mb/s, 2.4-GHz WLAN technology while, at the same time, unveiling its PRISM Indigo chip set for 54-Mb/s, 5-GHz WLANs in compliance with the newer IEEE 802.11a WLAN standard. The firm also announced plans to support the emerging IEEE 802.11g high-data-rate WLAN standard for 2.4-GHz systems. Throughout its booth, Intersil used PRISM Indigo technology to wirelessly transmit streaming audio and video. The product includes a Federal Communications Commission (FCC)-compliant reference design, a developer's kit, and application software. Intersil also announced a collaborative effort with Cisco Systems on high-speed WLAN client adapter reference designs aimed at the emerging 802.11g draft standard. The reference designs will support complementary-code-keying (CCK) and orthogonal-frequency-division-multiplexing (OFDM) modulation formats.

Systemonic (San Jose, CA) also announced its support of multiple 802.11 WLAN standards while displaying its full Tondelayo 5-GHz WLAN chip set, acquired late last year from Raytheon's RF Components group (Andover, MA). In addition to a set of RF integrated circuits (RF ICs) for handling radio RF and intermediate-frequency (IF) chores, the chip set includes a versatile baseband controller. The company detailed its roadmap for applying its OnDSP(TM) technology platform for rapid development of digital-signal-processing (DSP)-based baseband solutions and its Rflex(TM) technology for achieving superior receiver (Rx) sensitivity and frequency selectivity over a range of operating frequencies.

NextComm (Bellevue, WA) addressed the issue of security for WLANs. Com-



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pany spokespeople noted that the major weakness of today's 802.11b networks is the Wired Equivalent Privacy (WEP) protocol (the de-facto standard), which can be cracked in as little as 15 minutes. Recognizing the major flaw in WEP as the key-management system, where the keys remain static for extended time periods, President and CEO, Jerry Wang, said that Key Hopping® techniques change the key every 3 s. As a result, a hacker has less of a chance to obtain the key. As an encryption algorithm, the company believes that it would take hackers three to four years to decrypt it.

Murata Electronics North America (Smyrna, GA) introduced its integrated dual-channel active filter device for 5-GHz 802.11a WLAN baseband filtering. It consolidates many discrete components that are normally required to filter out frequencies above 9 GHz. It measures 9.5 × 12.5 × 2.2 mm.

Several other companies made WLAN announcements. William Carney of the Wireless Networking Business Unit of Texas Instruments (Dallas, TX) detailed the new IEEE 802.11g WLAN draft standard for achieving data rates up to 54 Mb/s in the 2.4-GHz band, and highlighted the company's intention to support the new standard. IceFyre (Kanata, Ontario, Canada) offered a white paper by Product Marketing Manager Tyler Burns on the remaining issues for ratification and FCC approval for the emerging IEEE 802.11g standard.

Additional IC Makers

Some exhibitors offered ICs for non-WLAN applications, including Chipcon (Oslo, Norway) with its single-chip complementary-metal-oxide-semiconductor (CMOS) CC1050 frequency-programmable RF transmitter (Tx). Suitable for home automation, automatic meter reading, as well as wireless alarm and security systems, the CC1050 RF Tx suits the 300-to-1000-MHz short-range-device (SRD) frequency bands.

California Eastern Laboratories (Santa Clara, CA) displayed NEC's model NE5520379A silicon (Si) laterally-diffused-metal-oxide-semiconductor (LDMOS) transistor for cellular phones and other wireless applications from ultra-high frequency (UHF) to 2 GHz. Designed for operating voltages from +3.2 to +7.5 VDC, the transistor delivers +35.5-dBm output power at 1-dB compression with 65-percent power-added efficiency (PAE) and 16-dB gain at 915 MHz and +3.2 VDC. The UPG2008TK gallium-arsenide (GaAs) monolithic-microwave-IC (MMIC) single-pole, double-throw (SP2T) switch measuring 1.3 × 1.5 mm was also announced. With 0.4-dB typical insertion loss at 1 GHz and 25-dB typical isolation at 2.5 GHz, the switch suits WLAN and Bluetooth designs.

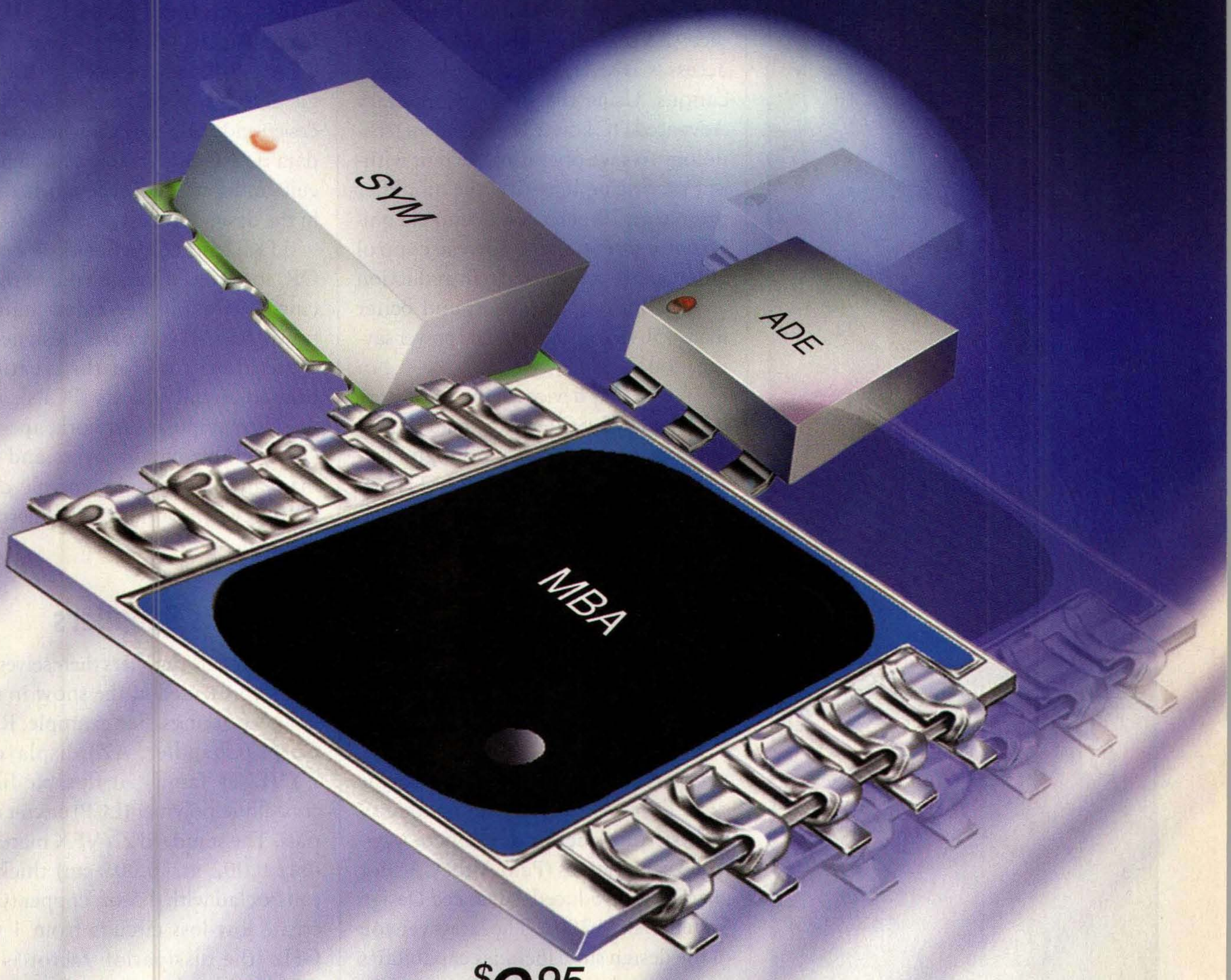
Analog Devices (Wilmington, MA) unveiled the AD8362, a root-mean-square (RMS) detector IC capable of operating to 2.7 GHz. The IC measures input power and provides a linear-in-decibels output voltage when optimizing and maintaining base-station output-power efficiency and linearity. It handles a dynamic range of 60 dB (−45 to +15 dBm) in a 50-Ω system.

IBM Microelectronics (Lowell, MA) surprised some visitors by launching several standard product lines, including power amplifiers (PAs) and voltage-controlled oscillators (VCOs). Based on IBM's innovative silicon-germanium (SiGe) semiconductor processes, the amplifiers include the model IBM2022 with +31.5-dBm output power at 1-dB compression from 824 to 849 MHz. The IBM3115 bipolar CMOS (BiCMOS) VCO spans 3589 to 3980 MHz for direct-conversion receive applications in Global System for Mobile Communications (GSM), digital-communications-services (DCS), and personal-communications-services (PCS) handsets. It features typical phase noise of −139 dBc/Hz offset 3 MHz from the carrier.

Peregrine Semiconductor (San Diego, CA) announced the PE3341 3-GHz integer-N phase-locked loop (PLL). It includes a field-programmable electrically erasable programmable read-only memory (EEPROM) register that allows designers to permanently store control bits, supporting easy configuration of various fixed-frequency synthesizers.

WIDEBAND

HIGH IP3 MIXERS



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Now you can obtain *spectacular wideband IP3 performance* at a value price with Mini-Circuits team of MBA, ADE, and SYM mixers. Optimized to deliver the highest IP3 for a given LO drive, these affordable surface mount mixers range from 32dBm IP3 for +17dBm LO power...to 15dBm IP3 for LO down to +4dBm. In terms of E Factor (IP3 Figure Of Merit), these mixers go as high as 1.5 providing superior intermodulation suppression from 5 to 5900MHz while at the same time achieving low conversion loss and high isolation. You'll also be pleased to know the Blue Cell™ MBA model covers your higher frequency designs with superb temperature stability, high repeatability, and ultra-thin 0.070" profile. Now, high IP3, higher performance, and value pricing have merged. The result is Mini-Circuits wideband high IP3 mixers...the *clear* choice!

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Typical Specifications:

Model	Freq. (MHz)	LO Level (dBm)	IP3 Midband (dBm)	E Factor*	Conv. Loss Midband (dB)	Price $ea. Qty. 10
ADE-10MH	800-1000	+13	26	1.3	7.0	6.95
ADE-12H	500-1200	+17	28	1.1	6.7	8.95
•MBA-591L	4950-5900	+4	15	1.1	7.0	6.95
SYM-25DLHW	40-2500	+10	22	1.2	6.3	7.95
SYM-25DMHW	40-2500	+13	26	1.3	6.6	8.95
SYM-24DH	1400-2400	+17	29	1.2	7.0	9.95
SYM-25DHW	80-2500	+17	30	1.3	6.4	9.95
SYM-22H	1500-2200	+17	30	1.3	5.6	9.95
SYM-20DH	1700-2000	+17	32	1.5	6.7	9.95
SYM-18H	5-1800	+17	30	1.3	5.75	9.95
SYM-14H	100-1370	+17	30	1.3	6.5	9.95
SYM-10DH	800-1000	+17	31	1.4	7.6	9.95

*E Factor = [IP3 (dBm) – LO Power (dBm)] ÷ 10. See web site for E Factor application note.
ADE models protected by U.S. patent 6,133,525.

•MBA Blue Cell™ model protected by U.S. patents 5,534,830 5,640,132 5,640,699.

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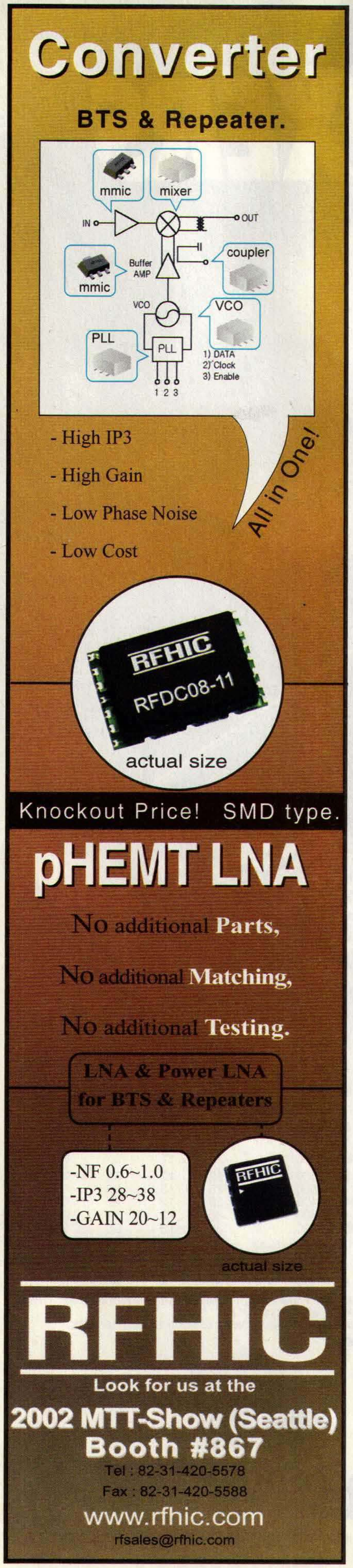

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Raytheon RF Components (Andover, MA) announced their model RMPA1956-103 dual-band, trimode PA for Advanced Mobile Phone Service (AMPS), code-division-multiple-access (CDMA), and cdma2000 applications. Using the firm's proprietary Advanced DC Power Management technology to save operating current without sacrificing linearity, the amplifier promises a 70-percent reduction in quiescent current at the lowest control voltage, 50-percent current reduction at +4-dBm output power, and better than −50-dBc linearity in DC power saving mode.

Not all new devices at the show were ICs. The FP750SOT343 medium-power-packaged pseudomorphic high-electron mobility transistor (PHEMT) from Filtronic (Santa Clara, CA) was developed for wireless-local-loop (WLL), WLAN, Global Positioning System (GPS), PCS, and GSM use. It features a 0.5-dB noise figure at 2 GHz and 17-dB power gain at that frequency.

Software Developers

Software booths loomed large over the show floor, with several key announcements from leading developers. Agilent Technologies (Palo Alto, CA), for example, introduced Advanced Design System (ADS) 2002. The latest version of the design suite includes capabilities for co-simulation with layout components, a verification model extractor, and several new simulation technologies, such as an improved transient microwave Simulation Program with IC Emphasis (SPICE) simulation and enhanced circuit-envelope and oscillator simulation capabilities.

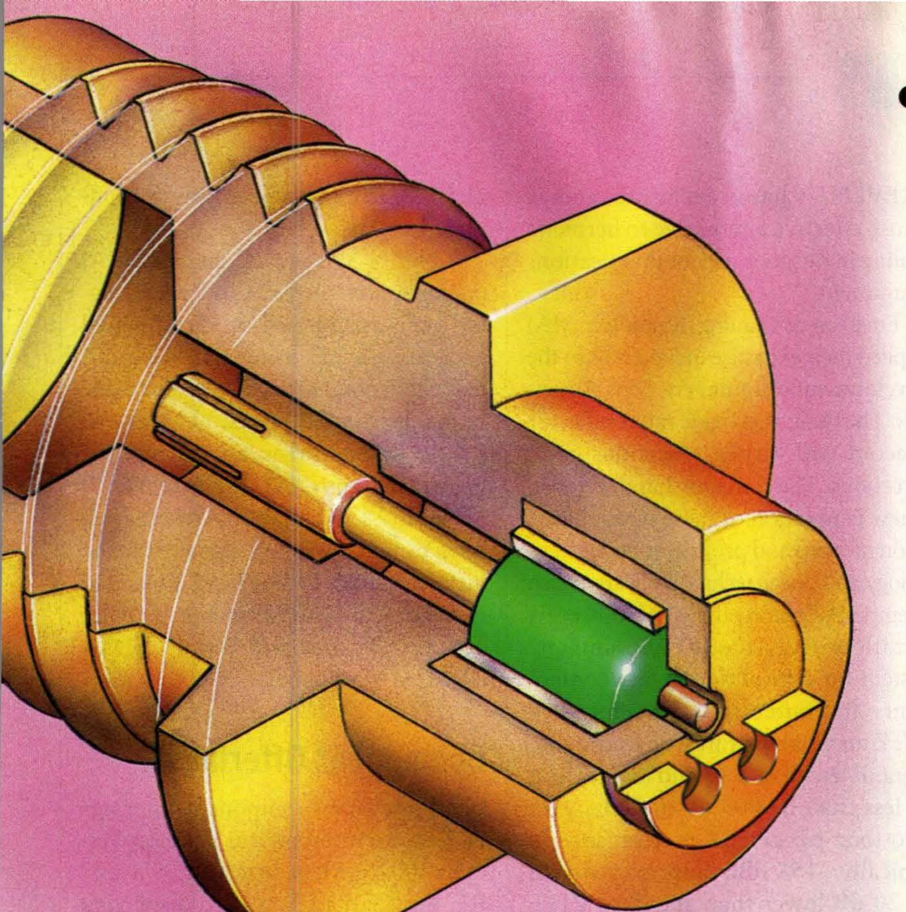
Eagleware Corp. (Norcross, GA) announced Version 8.1 of its GENESYS software suite, along with SPECTRASYS, a full spectral-domain system simulator that allows engineers to find the origin of spectral components. SPECTRASYS, which is integrated within the GENESYS suite, allows engineers to specify entire spectrums including measured data for frequency sources, such as synthesizers and oscillators. It helps to expose unwanted spurious products and intermodulation (IM) levels prior to system integration. According to Eagleware's Director of Product Marketing, Glenn Parker, "GENESYS with SPECTRASYS allows engineers to use a single design environment for RF system design and analysis by allowing automatic data transfer and manipulation for circuit- and system-level design at all steps in the design process."

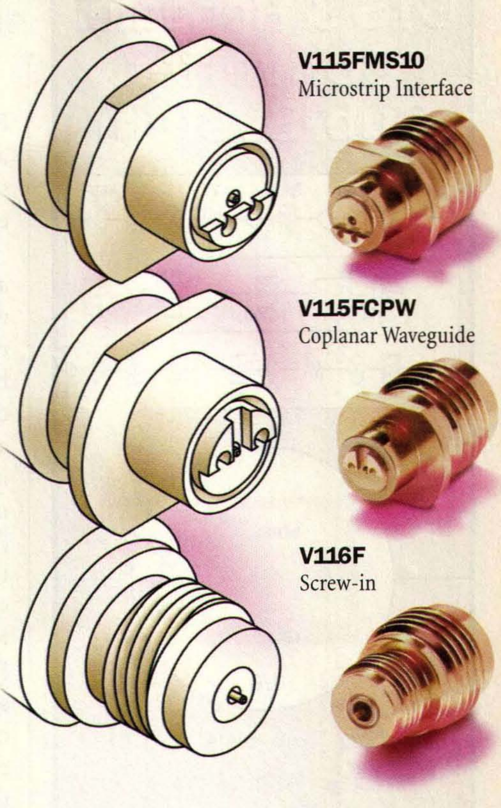
LPKF Laser & Electronics (Wilsonville, OR) introduced Version 4.0 of the CircuitCAM computer-aided-manufacturing (CAM) software. Designed as a stand-alone tool for the creation of printed-circuit boards (PCBs), it can readily manipulate artwork, apertures, and multiple circuit layers and automatically perform design rule checks (DRCs) when working with microwave substrate materials.

Materials Suppliers

The materials suppliers themselves were well-represented at the show in terms of new offerings. For example, Rogers Corp. (Chandler, AZ) displayed its ZYVEX™ family of flexible liquid-crystalline-polymer (LCP) circuit materials. The standard ZYVEX material is only 0.002 in. (0.005 cm) thick, but can be clad with 0.5-oz. copper (Cu) to create low-loss circuits from 1 to 10 GHz (the dissipation factor is only 0.002 over that range). The material exhibits a dielectric constant of 2.9 from 1 to 10 GHz and has a coefficient of thermal expansion that is well-matched to Si and Cu. ZYVEX is suitable for fabricating tape-drive head assemblies, flexible antennas, and liquid-crystal-display (LCD) drivers.

W.L. Gore & Associates (Newark, DE) announced a partnership with AB Tradex Converting (Kungalv, Sweden), a leading producer of self-adhesive components for the cellular-telephone industry. Under the agreement, Tradex will convert, sell, support, and automate the installation of GORE ALL-WEATHER™ membranes, felts, and GORE-SHIELD® electromagnetic-interference (EMI) gaskets. Gore also offered their





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Just think, no more worries about bead installation or if you've achieved a truly hermetic and low loss connection. You can be confident that your system has the finest broadband coaxial connections available.

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*Patents pending

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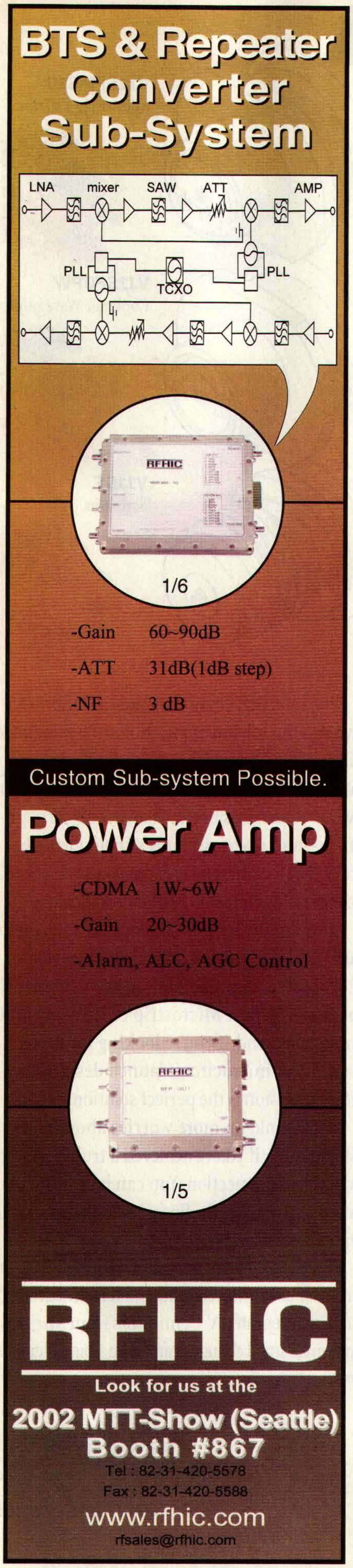

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PREVENT™ line of enclosure vents as a cost-effective alternative to hermetic sealing in outdoor telecommunications equipment.

Emerson & Cuming (Randolph, MA) applied their expertise in materials to the development of Luneberg Lens Antennas. The designs provide radar reflector beacons with strong reflections in all directions. The company has developed a new generation of these lenses based upon modern and proprietary filler technology and design techniques. Park/Nelco (Tempe, AZ) showed their N9000 polytetraflouroethylene (PTFE) laminate system for critical microwave components and antennas. The reinforced PTFE materials feature a dielectric constant of less than 2.17 and loss tangent of less than 0.0009 at 10 GHz, with two-tone passive IM performance of typically −155 dBc (approximately 8 to 20 dB lower than standard PTFE materials).

GIL Technologies (Colierville, TN) unveiled its new 60-mil-thick GML 2032 laminate material in preproduction quantities. The materials, which are suitable for antennas of other precise microwave components, feature a dielectric constant of 3.20 and loss tangent of 0.0029 at 10 GHz.

To evaluate components made with these new materials, several manufacturers offered new test equipment for signal generation and analysis. Noise Com, Inc. (Paramus, NJ), for example, displayed its DNG7500 digital noise generator for creating sophisticated noise waveforms for communications component and systems testing. With a 70-MHz RF bandwidth, the digital noise source provides continuous-wave (CW) signal resolution of 1 kHz and noise-signal resolution of 1 Hz. A 64-dB attenuation helps control output levels from a nominal maximum level of 0 dBm.

Tektronix (Beaverton, OR) announced the FSU26 microwave spectrum analyzer for evaluating signals from 20 Hz to 26.5 GHz. Suitable for third-generation (3G) cellular testing, the analyzer offers digital resolution-bandwidth filters from 10 Hz to 100 kHz and can sweep across analog resolution bandwidths as wide as 50 MHz for handling heavily modulated signals.

Celerity Systems (Cupertino, CA) demonstrated their CS2010 vector signal generator, based on direct signal generation at IFs using a 14-b digital-to-analog converter (DAC). Available in bands from 700 to 2200 MHz, the generator features an output in-phase/quadrature (I/Q) bandwidth of 30 MHz and the capability to create a wide range of wireless signal formats, including GSM, IS-136, IS-95, Enhanced Data rates for Global Evolution (EDGE), cdma2000, and wideband-CDMA (WCDMA) signals.

Component Offerings

High-frequency component offerings were well-represented at Wireless Systems 2002, with Nextec Microwave & RF, Inc. (Santa Clara, CA) displaying a single amplifier capable of 2-to-40-GHz coverage and as much as 1-W output power. Dow-Key Microwave (Ventura, CA) demonstrated its model 4101-ENET CANBus-based coaxial switch matrix with a built-in Ethernet port for remote monitoring. Operating from DC to 18 GHz, the switch provides up to 75-dB isolation between ports. The switch includes a LCD front-panel display and keypad for manual override.

MEMSCAP (Grenoble, France) introduced a MEMS-based filter technology for local-multipoint-distribution-services (LMDS) applications, automotive, and spaceborne millimeter-wave applications. The planar filters range from 18 to 90 GHz, using capacitively end-coupled resonators on a suspended dielectric membrane. The edge-coupled section of the microstrip line is used as a transformer coupling to the filter and setting the external quality factor (Q).

Winchester Electronics (Watertown, CT), a provider of high-speed interconnect products, displayed its lines of BMA blind-mate connectors for applications from DC to 18 GHz. With only 0.2-dB insertion loss at 6 GHz, the rugged connectors are designed for high-stress applications. MRF

Maury Microwave's Automated Tuners are Ideal for On Wafer RF Device Characterization Applications!

Maury Microwave's automated tuners are slide-screw, broadband precision devices used to introduce controlled impedances into device characterization systems. Each unit has two motor-driven probes inserted into a central slab line to vary impedance magnitude and phase.

The non-contacting nature of the tuner probes avoids the friction, chatter, and vibration typically found in other automated tuners. This, along with other high-stability design features, makes Maury automated tuners **ideal for on wafer device characterization and measurement.**

Photo courtesy of Cascade Microtech, Inc.

Typical on wafer device characterization setups include two automated tuners like the Maury MT982E30 units (shown here mounted on a Cascade Microtech Summit 12651 probe station).

INTRODUCING:

The **MT902A2 Pre-matching Tuner** (mounted on a 50 GHz Maury model MT984A01 2.4mm Automated Tuner in this photo) is designed to be a low loss wafer probe mount that can operate from 8.0 to 50.0 GHz.

For more information please contact our Sales Department, or visit our web site at: **www.maurymw.com**

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SDLVA spans 750 to 1250 MHz

THE MODEL SDLVA-0120-70-FN-07103 is an SDLVA that operates from 750 to 1250 MHz. The unit features VSWR of 2.5:1 with a logging range of 65 dB. TSS is −60 dBm typical and limited IF output is 0 dBm typical. Video output voltage is +1.175 VDC at −61 dBm and +2.15 VDC at +4 dBm. The amplifier is housed in a 3.75 × 1.50 × 0.40-in. (9.53 × 3.81 × 1.02-cm) package.

Planar Monolithics Industries, 7311-G Grove Rd., Frederick, MD 21704; (301) 631-1579, FAX: (301) 662-2026, e-mail: sales@planarmonolithics.com, Internet: www.planarmonolithicsindustries.com.

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Transceivers target handheld applications

THE SERIES 70 single-channel wireless Tx and Rx mini modules are available in FCC-certified models. The 70TX1 Tx has been approved for use in FCC Rule Parts 22, 74, 90, and 95. The 70RX1 Rx has received Part 15 approval. In models as separate Txs or Rxs, or combined as transceivers, the series 70 modules are offered in the 420-to-510-MHz range and are available in 12.5- or 25.0-kHz channel-spaced versions. Tx modules provide 10-mW power, while the Rxs feature dual conversion and sensitivity of −120 dB or better. The units use DC power and operate from an unregulated voltage range from +4.8 to +8.0 VDC. All units are housed in a metal case and feature SMD component construction for resistance to shock and vibration levels. Applications include radio remote-control devices for automation systems and data telemetry and control in wireless handhelds. P&A: less than $150.00 ea. (Rx/Tx pair or transceiver unit; small qty.).

HM Radio Technology, Inc., 2526 Mt. Vernon Rd., Suite B156, Atlanta, GA 30338; (678) 530-0252, FAX: (770) 234-5390, e-mail: HMRTI@aol.com.

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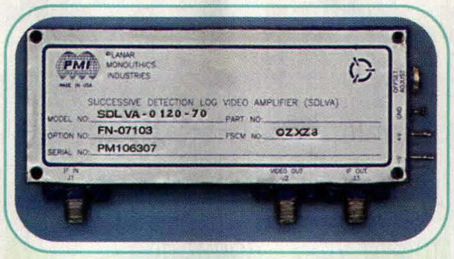
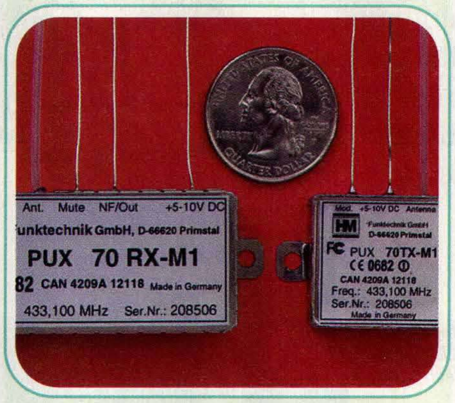
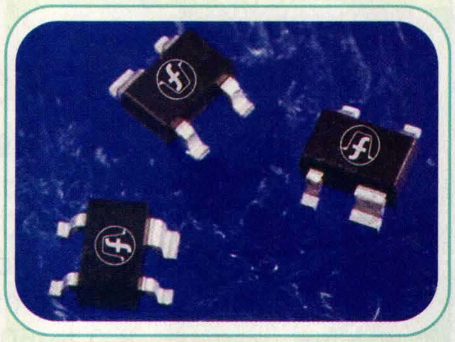


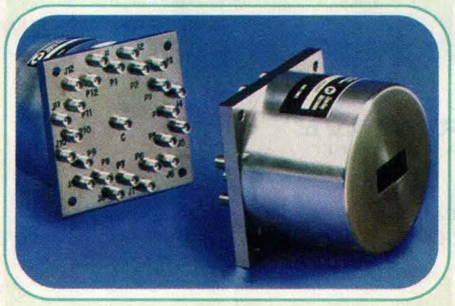
PLANAR MONOLITHICS SDLVA



HM RADIO TECHNOLOGY Tx/Rx MODULE



FILTRONIC SEMICONDUCTOR PHEMT



DOW-KEY MICROWAVE SWITCH MATRIX

PHEMT offers +21-dBm P1dB at 2 GHz

THE MODEL FP750SOT343 is a low-noise, medium-power-packaged PHEMT that is suitable for use in Rxs in WLL/RLL, WLAN, and GPS. The device can also be used in PCS and GSM base-station front ends. The PHEMT was designed for commercial systems using LNAs and oscillators operating over RF/microwave frequency ranges. The FP750SOT343 features a noise figure of 0.5 dB at 2 GHz and +21-dBm P1dB at 2 GHz. Power gain is 17 dB at 2 GHz and PAE is 45 percent.

Filtronic Semiconductor Operations, 3251 Olcott St., Santa Clara, CA 95054; (408) 988-1845, FAX: (408) 970-9950, Internet: www.filss.com.

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Switch matrix operates to 18 GHz

THE MODEL 13D12-480822T is a reconfigurable CANbus-based integrated switch matrix that is equipped with a built-in Ethernet port. The matrix is based on the standard design of the SP12T switch with internal termination. The matrix operates over the DC-to-18 GHz frequency range with a maximum VSWR of 1.80:1 at 18 GHz. Maximum insertion loss is 0.80 dB at 18 GHz and minimum isolation is 55 dB at 18 GHz. The device switches in 60 ms maximum and +24-VDC nominal operating current is 500 mA typical at 20°C. Access to the termination port through SMA connectors provides an opportunity to use the switch as a redundancy solution. Each unit is supplied with the contactless indicator circuitry which monitors the movement of the RF contact actuators using photosensors. Options include external 2-W CW 50-Ω terminations installed on all termination ports.

Dow-Key Microwave Corp., 4822 McGrath St., Ventura, CA 93003-7718; (805) 650-0260, FAX: (805) 650-1734, Internet: www.dowkey.com.

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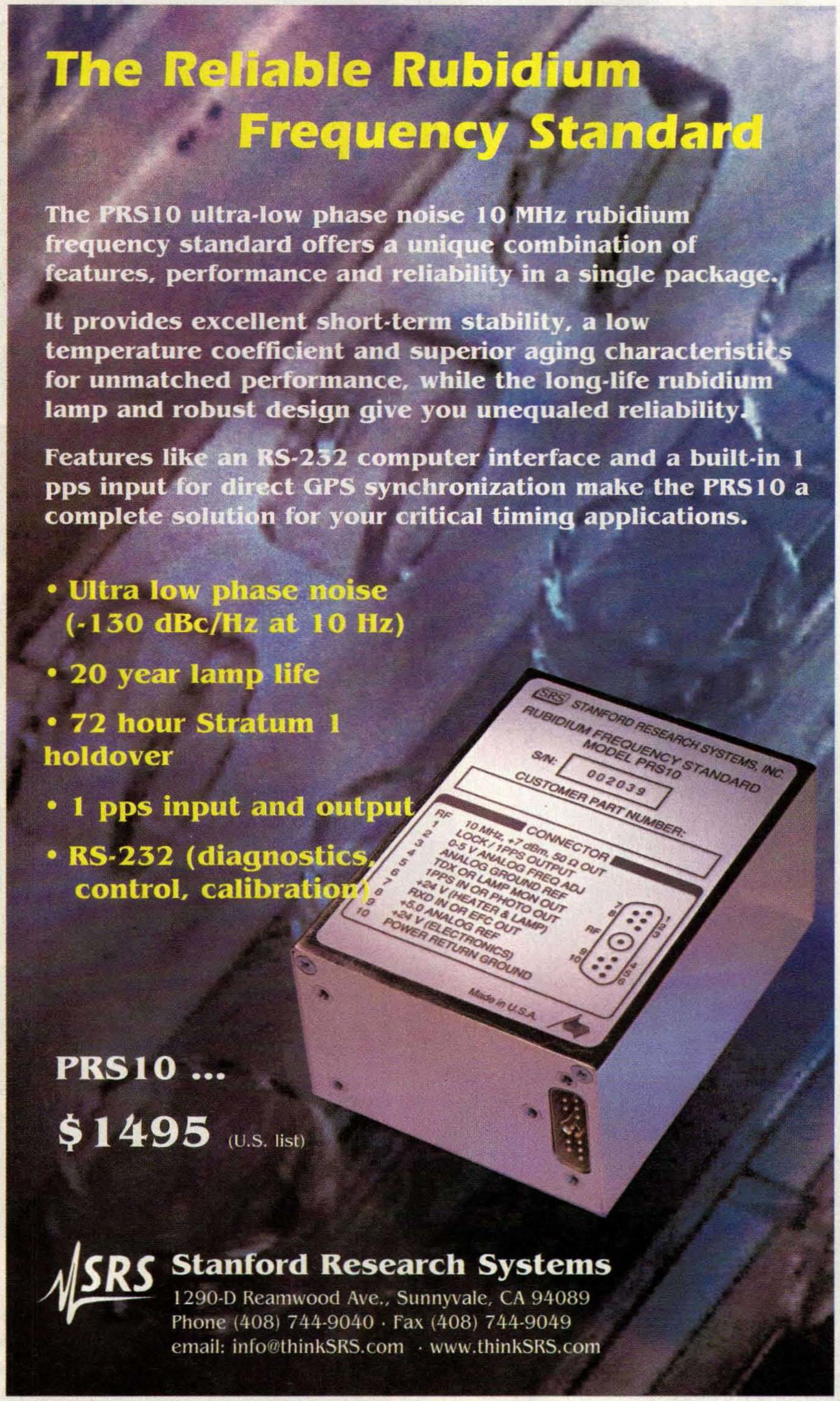
NEC Phones To Come To Europe

JAPAN'S LARGEST mobile-handset manufacturer has said that its expertise in mobile Internet technology will make its presence well-known in Europe. NEC Corp. is one company that appeared at this year's CeBIT trade fair, showing off new phones for the European market with color screens, tiny built-in cameras, and Internet connections which are all now standard features in Japan.



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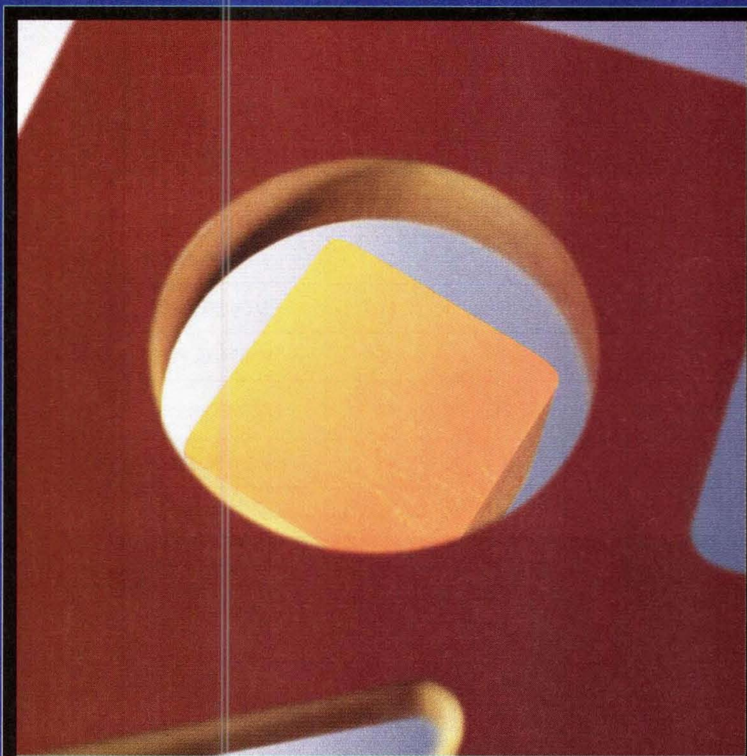
Many companies are eager to use this technology in Europe to gain market share that was previously lost, partially due to Europe's use of GSM. The standard differs in Japan, where PDC and PHS are used. NEC's general manager for mobile-phone marketing, Hiromi Orikawa, said, "NEC couldn't do much business in ordinary GSM phones."

NEC handsets were selected by E-Plus, Germany's third mobile operator and subsidiary of KPN Telecom, a Dutch carrier, for the European debut of i-mode, a mobile Internet-access service that has been very successful in Japan. KPN has said that it would start using i-mode-enabled handsets over the next few months from Japanese handset manufacturers—Toshiba Corp. and Mitsubishi Electric Corp.

Meanwhile, Matsushita Electric Industrial Corp., Japan's second-largest handset manufacturer, said it wants to rebuild its position in Europe with high-tech phones after delayed product launches caused the company to lose market share. Joachim Reinhart, President and COO of Matsushita Electric Europe Ltd., said, "We are spending a lot of money for R&D investment and the timely launch of products. We are on the way and we think we can regain our position with attractive products."

NEC is also targeting Europe's 3G mobile networks due to roll-out later this year with high-speed Internet connections and high-tech functions such as video-phone calling. Japan's dominant mobile carrier, NTT DoCoMo Corp., rolled out 3G service in Japan last Fall with handsets manufactured by NEC and Matsushita, but the subscriber base is still limited. In Europe, the Japanese companies are not dismayed by Finland's Nokia, Europe's dominant cellphone company, which has promised its own 3G handset by September. MRF



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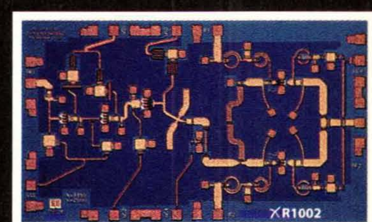
Mimix Broadband provides high performance GaAs MMICs for applications operating at 17 to 44+ GHz. Learn more about us at mimixbroadband.com.



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- Input internally matched to 50 Ohms

Market	Frequency (GHz)	Output Power P1dB (dBm)	Saturated Power (dBm)	Gain (dB)	PAE (@ Psat %)	Part Number
UNII & HiperLAN	5.0 - 6.0	26	+29	18	38	HMC406MS8G
		25	+29	15	28	HMC407MS8G
		23	+26	20	35	HMC415LP3
Wireless Local Loop	3.0 - 4.0	27	+30	21	45	HMC327MS8G
Cellular	1.5 - 2.3	27	+30	20	45	HMC413QS16G
MMDS	2.1 - 3.2	27	+30	20	32	HMC414MS8G

HMC327MS8G

- 3.0 - 4.0 GHz
- Output P1dB: 27 dBm
- Saturated Power: +30 dBm
- Gain: 21 dB

HMC406MS8G

- 5.0 - 6.0 GHz
- Output P1dB: 26 dBm
- Saturated Power: +29 dBm
- Gain: 18 dB

HMC413QS16G

- 1.5 - 2.3 GHz
- Output P1dB: 27 dBm
- Saturated Power: +30 dBm
- Gain: 20 dB

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CONTRACTS

EMS Technologies, Inc.—Announced that the General Services Administration (GSA) has named LXE, Inc., an EMS subsidiary, as an approved supplier to sell a range of wireless technology equipment to government customers. LXE and EMS are now eligible to sell products and services to government customers at "most favored customer" prices. Under this five-year agreement, government customers can access wireless equipment developed for COTS use, but with applicability in a variety of government operations.

Stratos Lightwave, Inc.—Has entered into a definitive agreement to acquire Tsunami Optics, Inc., based in Mountain View, CA. Under the terms of the agreement, Tsunami will become a wholly owned subsidiary of Stratos and the Tsunami shareholders will receive approximately 3.2 million shares of Stratos common stock. Stratos will also assume approximately $5.9 million of debt, along with certain expenses in connection with this transaction. Provided that Tsunami reaches certain financial-performance goals during the twelve-month period following the closing, an additional contingent payment of up to $18 million in Stratos common stock will be made in early 2003. Stratos expects the transaction to be accretive for its fiscal year 2003, and this will not be dependent on Tsunami achieving the minimum financial performance goals necessary to begin earning the additional consideration. The transaction will be accounted for as a purchase and is intended to qualify as a tax-free reorganization. The transaction is expected to close early in the Stratos' fourth fiscal quarter of this year and is subject to approval of Tsunami's shareholders and other customary conditions.

Renaissance Electronics Corp.—Signed a manufacturer's representative agreement with Testime Technology Ltd. of Basingstoke, Hampshire, England. Under the terms of the agreement, Testime will market Renaissance's product line of circulators/isolators, power dividers/combiners, and transceivers in the United Kingdom.

Orbit E-Commerce—Signed a three-year renewable sales and marketing agreement with TeleWrx, Inc. (TWI), with the goal of signing in excess of 1 million subscribers in Canada and the US. Under terms of the agreement, TWI will distribute Orbit's VoIP long-distance and Internet dial-up access service to residential and small business subscribers in major urban areas in the US and Canada—wherever Orbit establishes Points of Presence (POPs).

INTELEK plc—Announced that its subsidiary, Paradise Datacom LLC, has entered into a conditional agreement with Sierra Networks to purchase the business and assets of Sierra Networks' Satcom division. The acquisition will enable Paradise to to offer complementary SATCOM equipment to its existing customers, as well as offering its existing products to Sierra Satcom's customers. The total purchase price is a maximum of $4.968 million (approximately 3.51 million UK pounds). Of this, $4.268 million (approximately 3.02 million UK pounds) is payable in cash within seven days of completion. Payment of the remaining $0.7 million (0.49 million UK pounds) is dependent upon the sales of Sierra Satcom's products during the twelve-month period ending December 31, 2002.

FRESH STARTS

Ansoft Corp.—Announced that its revenue for the third quarter of fiscal 2002 totaled $14.1 million, an increase of 26 percent compared to $11.1 million reported in the previous fiscal year's third quarter. Pro forma net income for the third quarter of fiscal 2002 increased 42 percent to $2.1 million, or $0.15 per diluted share, which excludes the effects of the amortization of intangibles of $1.2 million and expenses of $1.1 million for Altra Broadband. This compares with a pro forma net income of $1.5 million , or $0.12 per diluted share, reported for the same quarter in the prior fiscal year, which excludes the effects of the amortization of intangibles of $599,000 and expenses of $481,000 for Altra Broadband. Net income for the third quarter of fiscal 2002 was $591,000 as compared to $707,000 in fiscal 2001.

Telenor—Has completed the acquisition of COMSAT Mobile Communications (CMC) and is combining it with Telenor Satellite Mobile to form Telenor Satellite Services. The name changes signify completion of Telenor's acquisition of CMC from Lockheed Martin Global Telecommunications (LMGT), as originally announced on March 27, 2001. COMSAT Mobile has annual revenues in excess of $100 million and was part of Lockheed Martin's earlier acquisition of COMSAT Corp. on August 3, 2000.

Allgon—Has been appointed as infrastructure supplier by Teracom, a Swedish supplier of transmission capacity for telecommunication services. According to the agreement, which is valid up to and including 2004, Allgon will provide piesiochronous-digital-hierarchy (PDH) radio equipment and services.

LCC International, Inc.—Announced that it has acquired Transmast Italia S.R.L., a wireless infrastructure, deployment, civil-engineering, and project-management firm located in Milan, Italy. LCC acquired Transmast S.R.L. from Transmast Ltd., a provider of antenna masts for base stations for mobile telecommunications networks. The two companies have been working together for approximately a year and have bid together on several opportunities after they announced a joint marketing agreement in December 2000.

RF Micro Devices—Has begun production in its second GaAs HBT fabrication facility (fab), which is located in Greensboro, NC on the company's headquarters campus.

Andrew Corp.—Has completed construction of the first commercially deployed non line-of-sight MMDS system for CommSpeed in Prescott, AZ. MRF

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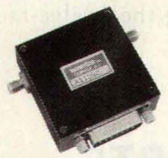

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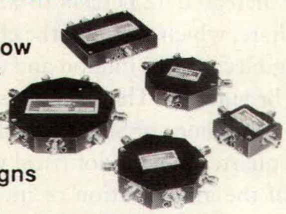

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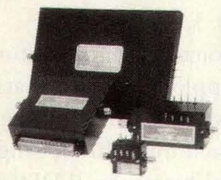
- Custom Designs



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ALTIMARI

Altimari Joins Tampa Microwave Labs In VP Spot

Tampa Microwave Labs announced that SHARON ALTIMARI has joined the company as vice president of marketing. Prior to accepting her current position at TML, Ms. Altimari was employed by Celerity Systems of Cupertino, CA as vice president of sales.

Sirenza Microdevices—JOHN PELOSE to vice president for wireless products; formerly director of wire-line products.

CenturyTel—NOLAN A. MOULLÉ, JR. to vice president of revenues; formerly vice president of separations and access.

Lambda—DON NAAB to president; formerly COO at Centurion Wireless Technologies.

Superconductor Technologies, Inc.—RICH CONLON to senior vice president of sales and marketing; formerly vice president of North American sales for Repeater Technologies.

Unitek Miyachi International (UMI)—HARRY R. ANDERSEN to chief marketing officer; formerly director of global marketing and new business development at Stanley Electric Co. Ltd.

Mericom Corp.—TED CARRIER to CFO; formerly president and CEO of Willitech International.

Wasabi Systems—JOHN SMITHMYER to head of sales initiatives for embedded BSD operating systems; formerly BSD products global sales manager for Wind River Systems.

Tekelec—LORI CRAVEN to vice president and general manager of the Network Systems Division; formerly vice president of mobility solutions development at Lucent Technologies.

Vettro—JOSEPH RYMSZA to CEO; formerly vice president of sales and recruiting at Cysive, Inc.

Hybrid Networks, Inc.—SCOTT C. MCDONALD to executive vice president and CFO; formerly employed at Conixon Corp.

TECOM Industries—ARSEN MELCONIAN to director of engineering at the Thousand Oaks, CA facility; formerly team leader systems engineer at Northrop Grumman Guidance and Control Systems.

Rogers Corp.—MARIO KERR to vice president of marketing and sales; formerly director of marketing.

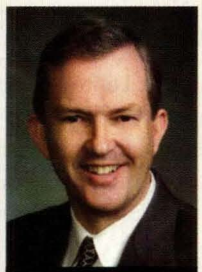
MariTEL, Inc.—DAN SMITH to president and CEO; formerly executive vice president of Latin America North for BellSouth International.

Avnet, Inc.—ROBERT W. MASON to vice president and chief information officer; formerly executive vice president and chief information officer at Cendant Corp.

IceFyre Semiconductor—RICHARD MONKMAN to CFO; formerly vice president of finance, global sales, marketing, and customer service at Nokia Internet Communications.

Palomar Technologies, Inc.—BRUCE W. HUENERS to vice president of marketing; formerly director of marketing.

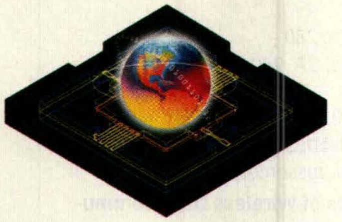
HUENERS



BLAKEY

Accent Optical Technologies—PETER BLAKEY, PH.D. to director of product marketing, DIVA, Optoelectronics Division; formerly director of characterization, modeling, and simulation at ON Semiconductor.

Southampton Photonics (SPI)—DR. STEVE NORMAN to vice president of operations and engineering; formerly director of UK operations. MRF



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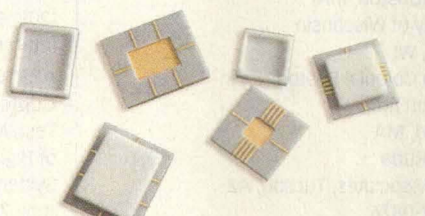

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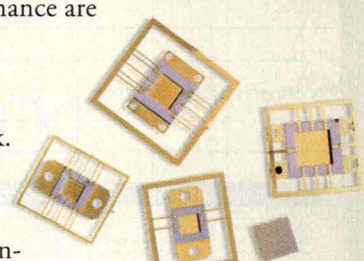

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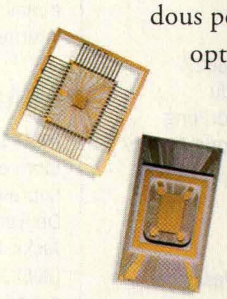

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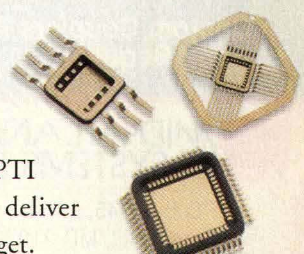

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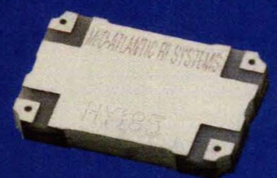

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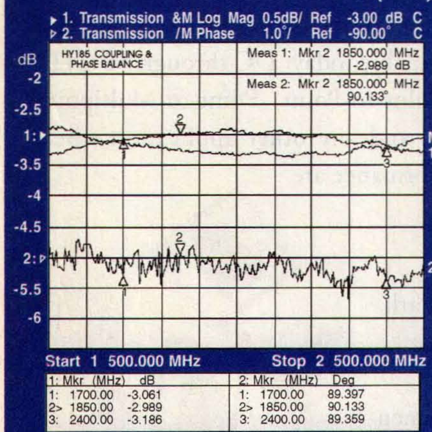

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Dan Danbeck
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Test, Measurement, and Characterization of High-Speed Digital Components And Systems
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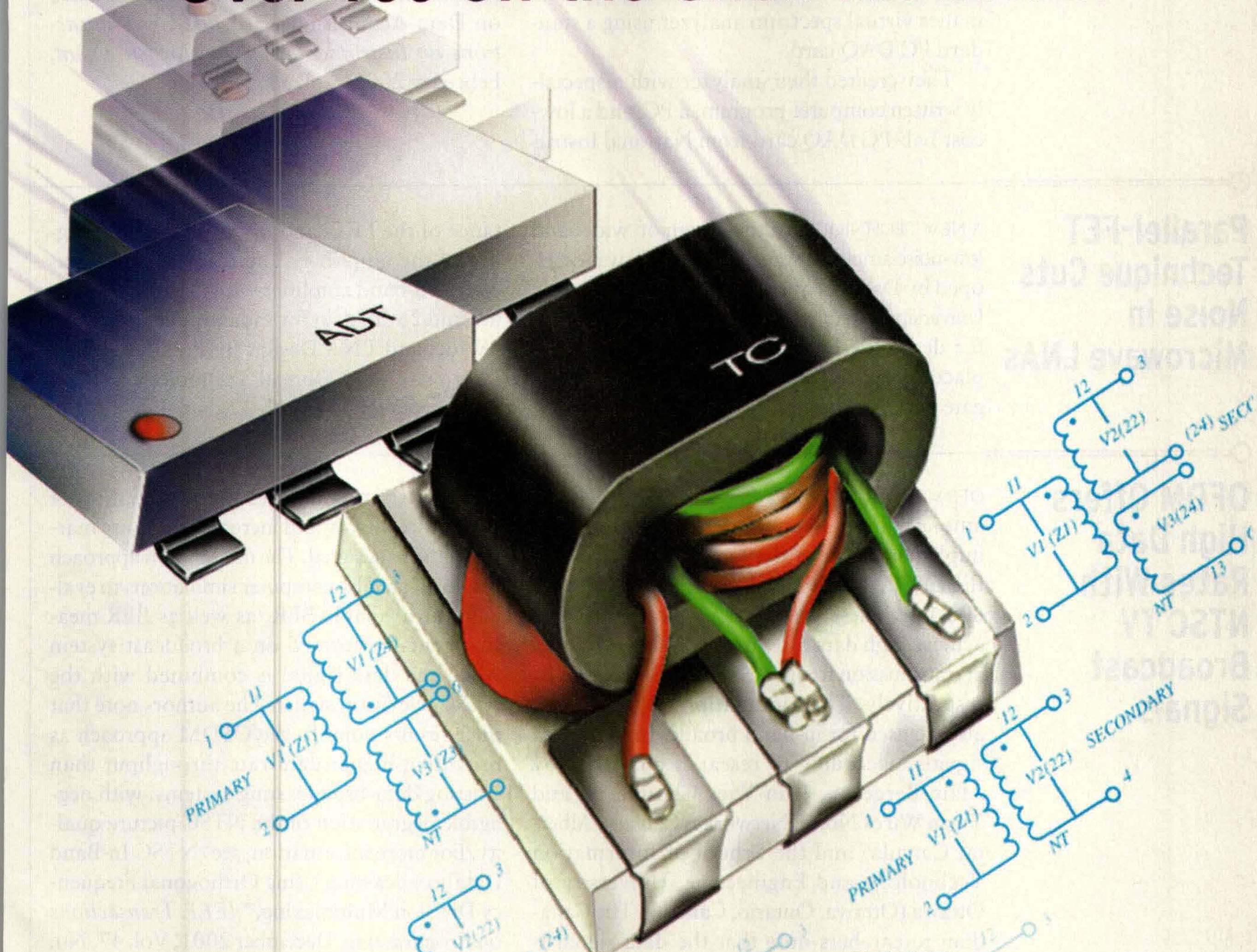

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Assemble A Spectrum Analyzer With A DAQ Card

SPECTRUM ANALYZERS ARE powerful measurement tools for audio, RF, and microwave applications, but they tend to be expensive. For that reason, Piotr Bilski and Wieslaw Winiecki of the Institute of Radioelectronics of the Warsaw University of Technology (Warsaw, Poland) explored the development of a high-performance virtual spectrum analyzer using a standard PC DAQ card.

They created their analyzer with a specially written computer program, a PC, and a low-cost Lab-PC DAQ card from National Instruments (Austin, TX). The researchers implemented several DSP functions, including digital filters, signal-fragment windows, and FFTs. Although their research was performed with a 350-MHz PC, the authors surmised that the same techniques could be applied to higher-speed computers. See "Virtual Spectrum Analyzer Based on Data Acquisition Card," *IEEE Transactions on Instrumentation and Measurement,* February 2002, Vol. 51, No. 1, p. 82.

Parallel-FET Technique Cuts Noise In Microwave LNAs

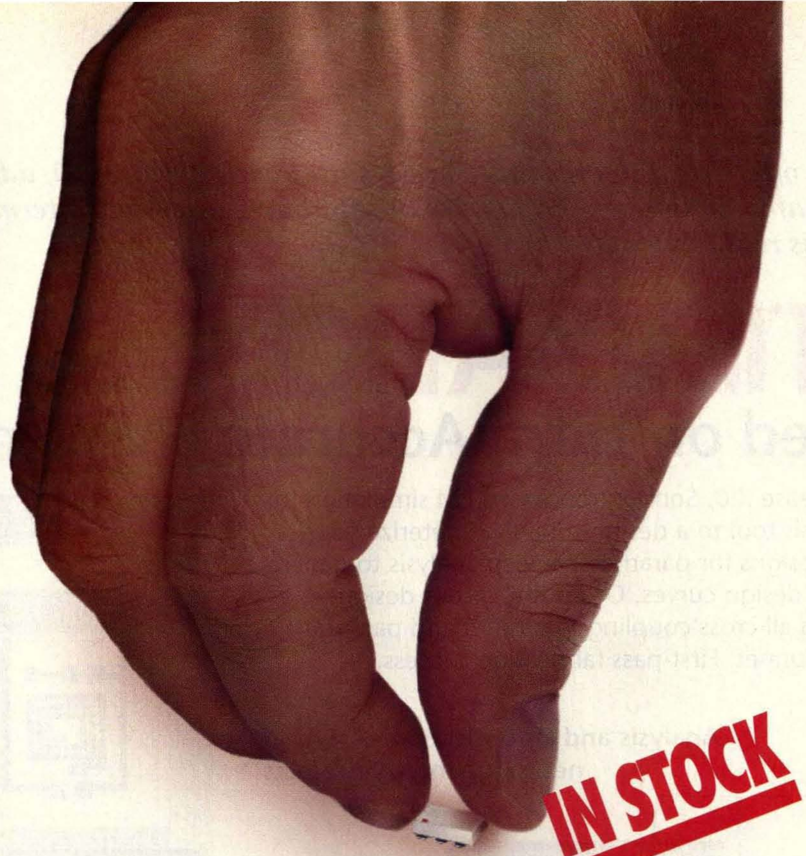
A NEW TECHNIQUE for the design of wideband low-noise amplifiers using parallel FETs was developed by Dario Benvenuti and associates of the University La Sapienza of Rome. In this approach for designing hybrid LNAs, many FETs are placed in parallel to effectively increase the gate periphery to increase in the input capacitance of the FETs and optimize the noise figure of the amplifier. The researchers assembled an S-band amplifier with 0.7-dB noise figure and 26-dB gain for radar applications. See "Wideband LNA Design By Parallel FETs," Microwave and Optical Technology Letters, February 20, 2002, Vol. 32, No. 4.

OFDM Offers High Data Rates With NTSC TV Broadcast Signals

OFDM HAS RECEIVED a great deal of attention among wireless-system designers due to its implementation in the latest versions of the IEEE WLAN standards, IEEE 802.11a and 802.11g. These standards employ OFDM to achieve high data rates over wireless networks at transmission frequencies of 5.2 and 2.4 GHz, respectively. The modulation approach can also be used for in-band broadcasting of data signals, according to research published by Alain Bergeron, Jean-Yves Chouinard, and Yiyan Wu of Nortel Networks (Calgary, Alberta, Canada) and the School of Information Technology and Engineering, University of Ottawa (Ottawa, Ontario, Canada). The Canadian researchers note that the data signal is inserted into the vestigial sideband of the NTSC video-broadcast signal and the shaping of the data spectrum minimizes the degradation of the picture quality and increases the noise margin of the data signal. The modulation approach was evaluated by computer simulations to evaluate the available BER, as well as BER measurements performed on a broadcast system when the data signal is combined with the NTSC television signal. The authors note that their results point to the OFDM approach as providing higher data-rate throughput than existing data-broadcasting systems, with negligible degradation of the NTSC picture quality. For more information, see "NTSC In-Band Databroadcasting Using Orthogonal Frequency Division Multiplexing," *IEEE Transactions on Broadcasting,* December 2001, Vol. 47, No. 4, p. 325.

Analyzing Ribbon Cables For High-Speed Digital Applications

MULTICONDUCTOR CABLES SUCH as ribbon cables are widely used in communications systems. With the growth of high-speed digital communications systems, however, these cables are required to handle ever-faster data rates. To evaluate the performance of these cables in a high-speed digital network, Chun-Wen Paul Huang and associates from ANADIGICS (Warren, NJ) and Auburn University explored modeling techniques for ribbon cables. They applied finite-difference and FDTD methods to analyze and optimize the electrostatic performance of ribbon cables. The cable under investigation was a 40-conductor, 28 AWG ribbon cable. Measurements through 10 GHz for verification of the modeled results were made on an HP 8753D VNA from Agilent Technologies (Santa Rosa, CA) with close agreement to the simulated values for the cable. See "Analysis and Design of Ribbon Cables for High-Speed Digital Applications," *International Journal of RF and Microwave Computer-Aided Engineering,* March 2002, Vol. 12, No. 2, p. 148. MRF



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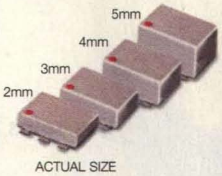

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ADE-3L	+3	0.2-400	5.3	47	10	4	4.25
ADEX-10L	+4	10-1000	7.2	60	16	3	2.95
ADE-1	+7	0.5-500	5.0	55	15	4	1.99▲
ADE-1ASK	+7	2-600	5.3	50	16	3	3.95
ADE-2ASK	+7	1-1000	5.4	45	12	3	4.25
ADE-6	+7	0.05-250	4.6	40	10	5	4.95
ADEX-10	+7	10-1000	6.8	60	16	3	2.95
ADE-12	+7	50-1000	7.0	35	17	2	2.95
ADE-4	+7	200-1000	6.8	53	15	3	4.25
ADE-14	+7	800-1000	7.4	32	17	2	3.25
ADE-901	+7	800-1000	5.9	32	13	3	2.95
ADE-5	+7	5-1500	6.6	40	15	3	3.45
ADE-5X	+7	5-1500	6.2	33	8	3	2.95
ADE-13	+7	50-1600	8.1	40	11	2	3.10
ADE-11X	+7	10-2000	7.1	36	9	3	1.99▲
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ADE-3G	+7	2300-2700	5.6	36	13	3	3.45
ADE-28	+7	1500-2800	5.1	30	8	3	5.95
ADE-30	+7	200-3000	4.5	35	14	3	6.95
ADE-32	+7	2500-3200	5.4	29	15	3	6.95
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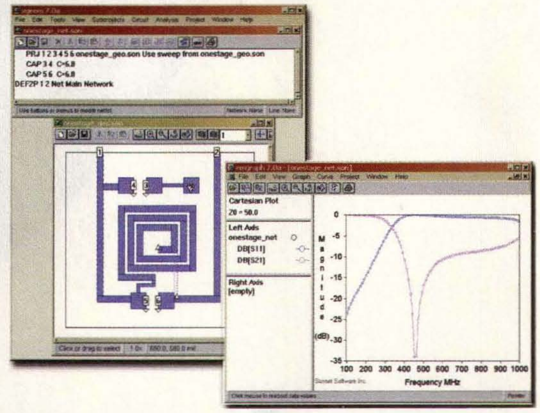

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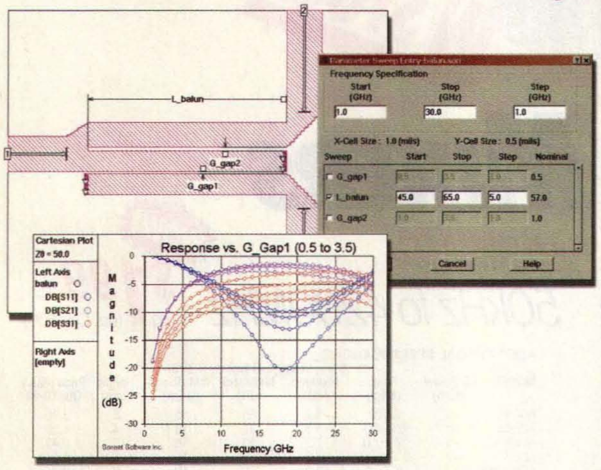

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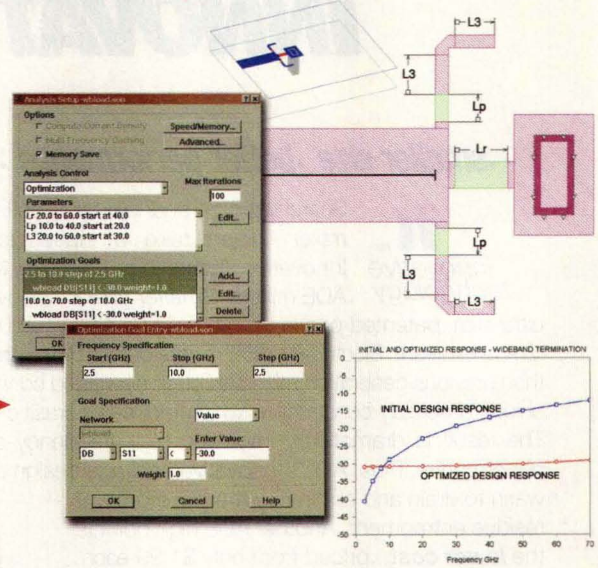

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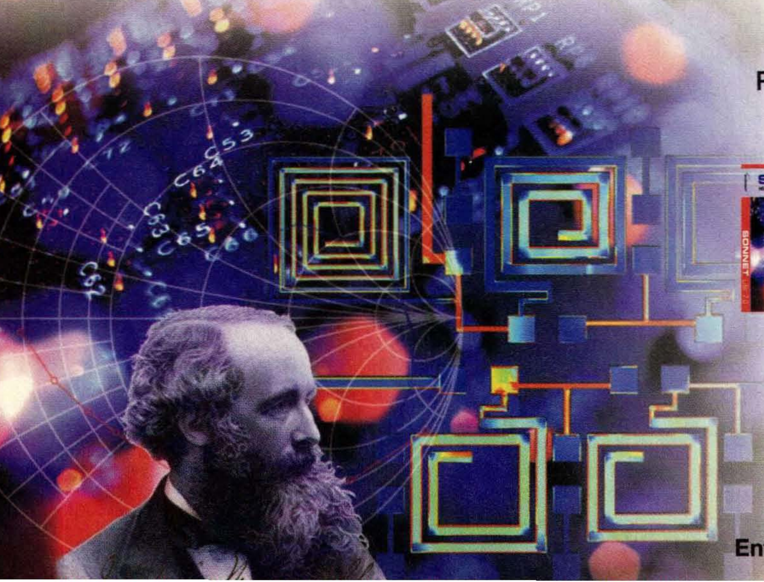

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DESIGN

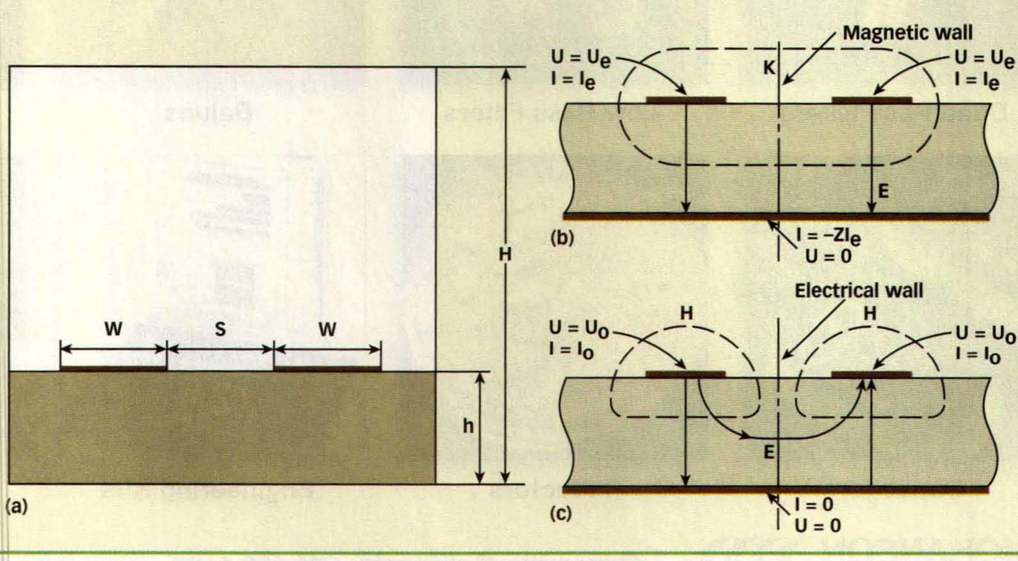
Improve BPF Performance With Wiggly Coupled Lines

The use of wiggly coupled-line resonators can improve the second- and third-harmonic rejection of miniature microstrip bandpass filters.

Microstrip coupled-line bandpass filters (BPFs) are used in many applications. They feature the high selectivity needed to reject unwanted signals and interference.[1,2] Unfortunately, conventional microstrip coupled-line BPFs suffer parasitic passbands at twice the center frequency, due to the unequal even- and odd-mode phase velocities in microstrip coupled lines. A novel microstrip filter design using wiggly coupled-line resonators can achieve second- and third-harmonic attenuation that is superior to conventional microstrip coupled-line BPFs, and at a fraction of the size.

LEO G. MALORATSKY
Principal Engineer
Rockwell Collins, 1100 West Hibiscus Blvd., Melbourne, FL 32901; (321) 953-1729, FAX: (321) 953-1646, e-mail: lgmalora@rockwellcollins.com.

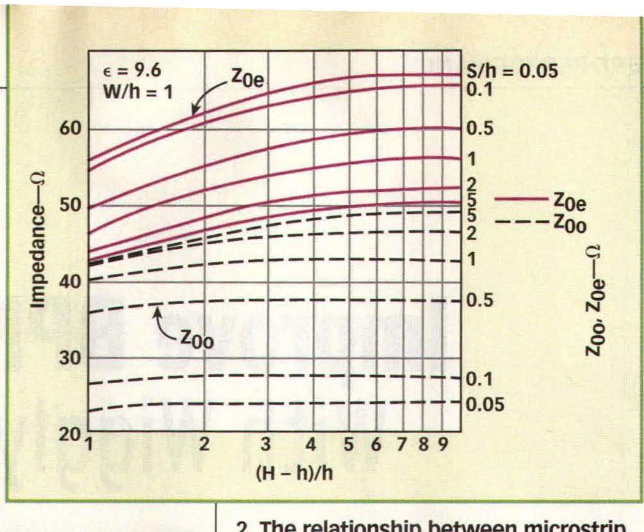
For traditional microstrip coupled lines **(Fig. 1)**, the dielectric medium is inhomogeneous. The dielectric substrate fills the cross section of the transmission lines only partially and, because the dielectric constant, ϵ, is greater than unity, the EM field is more concentrated in the substrate than in the air.



1. The basic configuration of microstrip coupled lines is shown inside a housing (a), with even- (b) and odd-mode (c) electromagnetic (EM) fields.

The large imbalance between the effective dielectric constants and the related phase velocities for the even and odd modes can lead to some limitations in the application of microstrip coupled lines. Extensive calculations have been performed to obtain practical design information.[1-5]

When coupled microstrip lines are enclosed in a real metallic housing (Fig. 1a), the configuration of the electric field lines changes. In this case, the capacitances will increase, and the effective dielectric constants and impedances will decrease **(Fig. 2)**.



2. The relationship between microstrip coupled-line impedance and housing height is shown here.

Table 1: Harmonic attenuation for the wiggly two-pole BPF

Relative open stab length (1/Λ)	INSERTION LOSS (dB) f_o=4590 MHz	f_o/2=2295 MHz	2f_o=9180 MHz	3 f_o=13770 MHz	4 f_o=18360 MHz
0.125	1.98	27.0	47.0	39.0	13.0
0.1	2.01	26.8	42.0	39.0	13.2
0.083	2.00	31.4	37.5	7.45	18.3
0.071	1.98	31.3	34.6	12.3	27.0
0.062	1.98	31.1	33.0	13.8	18.4
0.048	1.99	30.9	29.2	7.13	31.8
0	2.03	30.6	9.6	13.8	18.4

The upper metal cover can be neglected provided that its distance from the substrate H-h is greater than 6 to 8 h. Otherwise, the cover will affect the even-mode characteristic impedance (Z_{0e}), the odd-mode characteristic impedance (Z_{0o}), and the effective dielectric constant (ϵ_{eff}).

The typical planar bandpass filter **(Fig. 3)** consists of a cascade of parallel-cou-

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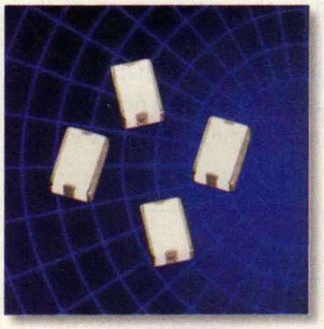
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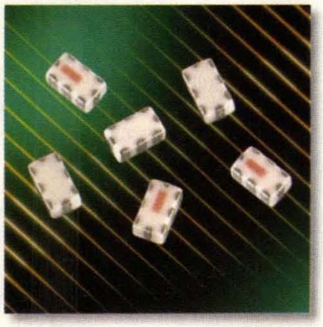
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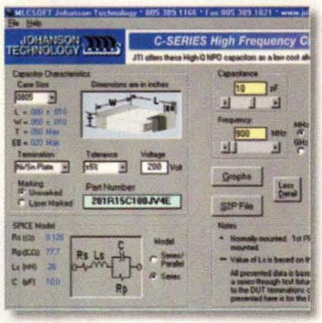

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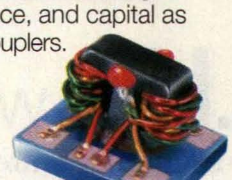

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13dB	DBTC-13-5-75	5-1000	1.0	19
		1000-1500	1.4	17
16dB	DBTC-16-5-75	5-1000	1.0	21
		1000-1500	1.3	19
17dB	DBTC-17-5	50-1000	0.9	20
		1000-1500	1.0	20
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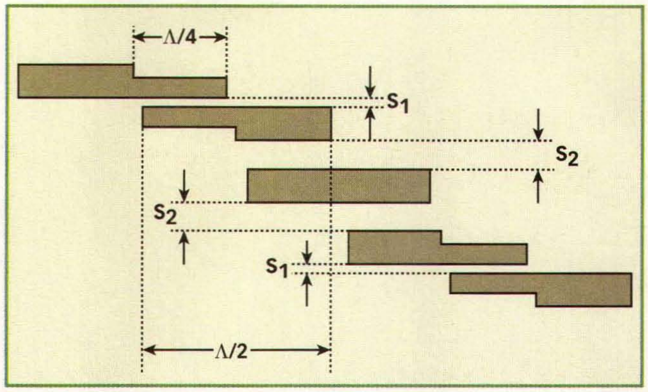
pled half-wavelength-long printed resonators that are open circuited at both ends. The resonators are positioned parallel to each other, so that adjacent resonators are coupled along a length equal to the quarter-wavelength of the center frequency of the filter. There are some problems associated with the coupled-line BPF design. One is that the open end of a strip conductor emits some radiation that can be seen as either adding to capacitance or increasing the effective length of the resonator. The open-end effect on both ends of each resonator increases the electrical length of the resonator and decreases the operating frequency of the filter. The parasitic reactances of the open resonators can be compensated by shortening the resonator lengths.

Theoretically, the first spurious response of a coupled-line BPF occurs at three times the center frequency, which is true of pure transverse-EM (TEM)-mode media such as stripline filters. In a practical microstrip parallel-coupled BPF, a spurious mode occurs at approximately twice the passband frequency due to the different even- and odd-mode propagation velocities of the coupled resonators.

Table 2: Simulation results for the wiggly coupled-line BPF

PARAMETERS	STUB LENGTH	
	l=0	1 = Λ/8
Insertion loss (dB)	2.1	1.98
3-dB bandwidth (%)	4.2	5.3
15-dB bandwidth (%)	22.9	25.9
15-dB bandwidth (%) / 3-dB bandwidth (%)	5.45	4.89



3. This configuration shows a traditional parallel coupled-line BPF.

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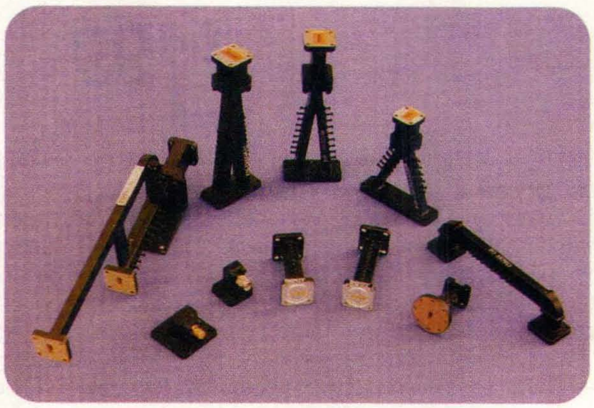

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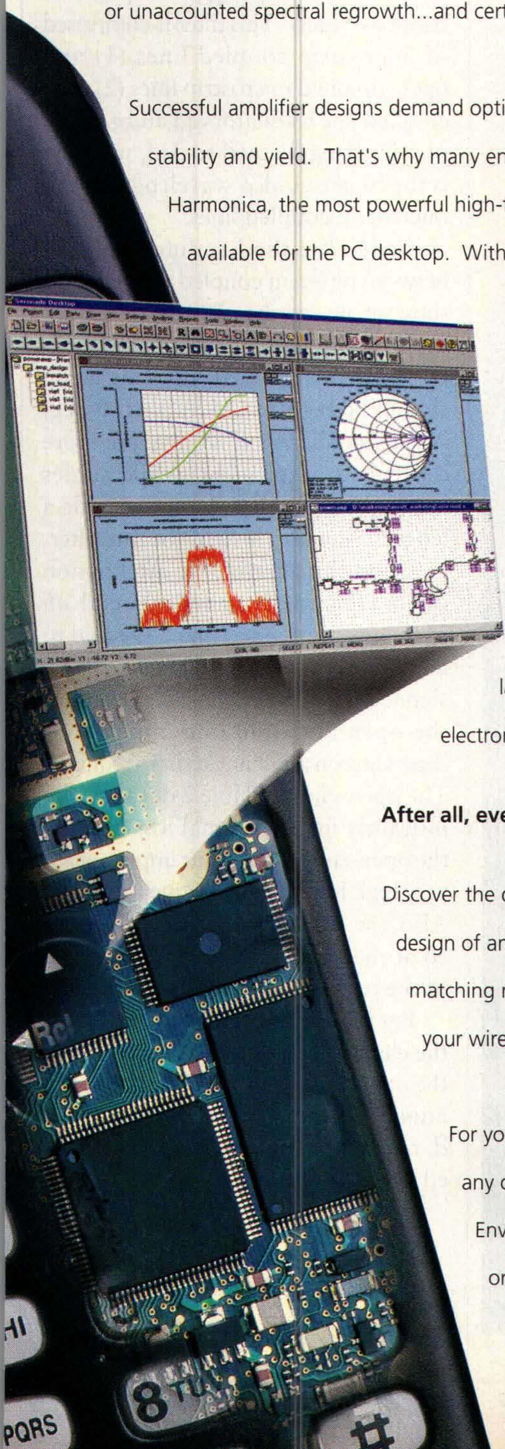

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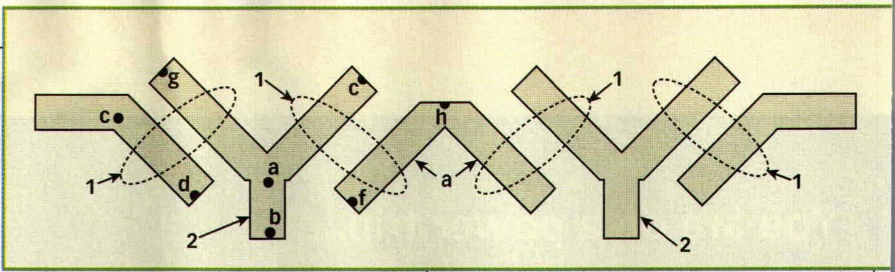
Two methods can be used to resolve this problem: equalizing the phase velocities and providing different lengths for the even and odd modes.[6-8] However, all of these methods increase the loss and cost, and provide imperfect attenuation for higher-order modes. Also, as with many microelectronic circuit components, the required physical size of a conventional microstrip BPF is a limitation to circuit miniaturization.



4. The novel microstrip wiggly coupled-line BPF achieves improved second- and third-harmonic suppression.

The filter described in this article improves the performance of conventional microstrip BPFs. **Figure 4** illustrates the new microstrip wiggly coupled-line bandpass filter.[9] This filter is comprised of microstrip coupled lines (1) and open-circuited microstrip lines (2). The coupled line resonators *cd* and *ga* have physical length equal to $\Lambda/4$, where Λ is the center-guided wavelength at the microstrip coupled lines.

Generally, the banding angle, α, between different coupled resonators is substantially less than 180 deg. to reduce the overall physical length of the filter. In many applications, this angle should be between 25 and ~100 deg. Angles smaller than 25 deg. are more difficult to implement, while angles larger than 100 deg. do not provide a length-reduction benefit for this filter.

Good third-harmonic attenuation can be realized if the physical length *ab* of the open-circuited line 2 is equal to the guided quarter-wavelength of the input signal's third harmonic. The length of the open-circuited line 2 may vary depending on the characteristics required. The open-circuited line 2 does not significantly increase signal loss because the open-ended line input impedance is very high for the main frequency signal. Also, the open-circuited line 2 is located at the minimum EM-field position of the resonators.

For the line *cd* coupled to the line *ag*, the electrical phase, ϕ_1, of the signal in the open end, *d*, and the phase of radiation signal, ϕ_{1rad} from the input end, *d*, relative to input *c*, can be calculated from ϕ_{1rad} by:

$$\varphi_1 = \varphi_{1rad} = arctg\frac{2Z\sin\Theta_1\cos\Theta_1}{\cos^2\Theta_1 - Z\sin^2\Theta_1} - \frac{\pi}{2},$$

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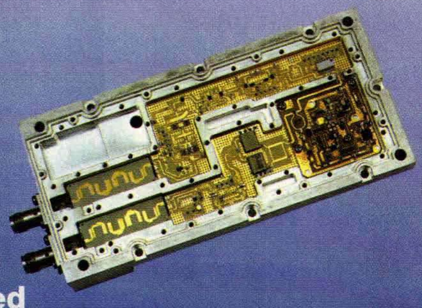

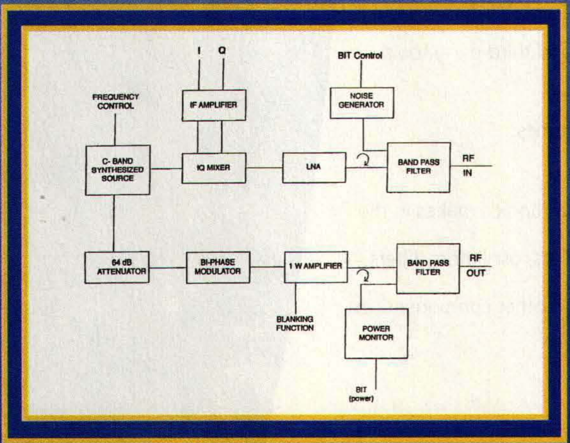

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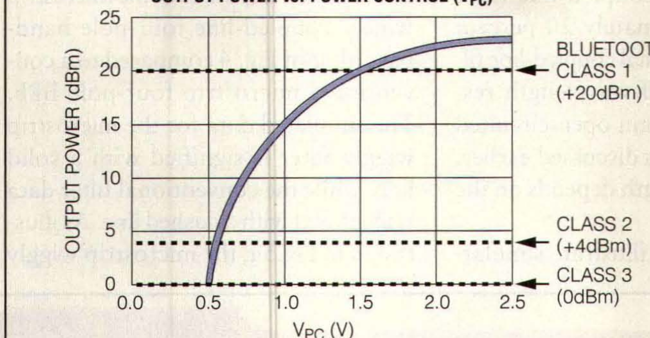

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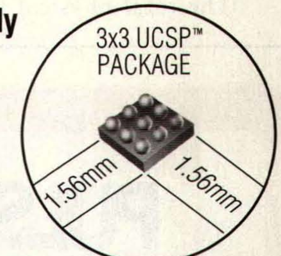

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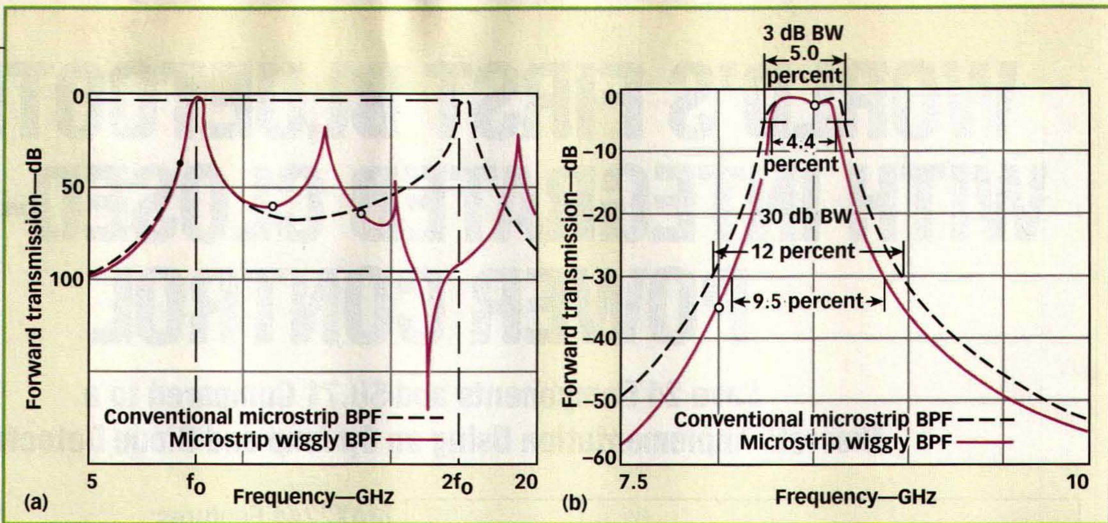
Z = the normalized impedance of line,

$\Phi_l = 2\pi l_l/\Lambda$ = the electrical length of the line, and

l_l = the physical length of the line.

Parameter Φ_l for the quarter-wave-length input line *cd* is equal to $\pi/2$, therefore making ϕ_l = $\phi_{lrad} = -\pi/2$. For the line *fh*, the electrical phase, ϕ_2 of the signal in the open end is $\phi_2 = \phi_1 = -\Lambda/2$.

However, the phase of radiation signal is equal to $\phi_{2rad} = -\phi_2 = -\phi_{1rad}$. Therefore, resonators that contain open-circuited lines reduce free-space radiation due to the phase cancellation of fields at the ends *d* and *f*.



5. These simulation results compare the second-harmonic attenuation (a) and bandpass responses (b) of conventional and microstrip wiggly coupled-line BPFs.

The total physical length of the microstrip wiggly coupled-line filter (Fig. 4) is approximately 20 percent less than a conventional coupled-line filter because the half-wavelength resonators which contain open-circuited lines are banded. As discussed earlier, the reduction in length depends on the banding angle, α.

Figures 5a and b illustrate simulated frequency responses of the microstrip wiggly coupled-line four-pole bandpass filter of Fig. 4 compared to a conventional microstrip four-pole BPF. The simulated data for the microstrip wiggly filter is signified with a solid line, while the conventional filter data is identified with a dashed line. As illustrated in Fig.5a, the microstrip wiggly

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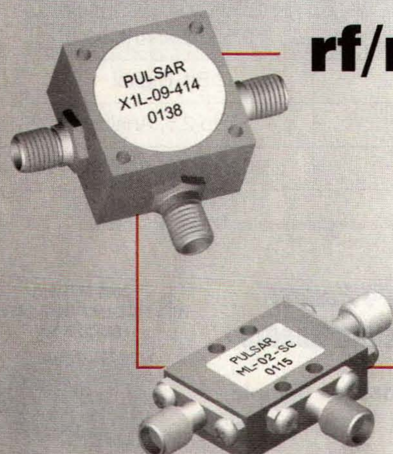

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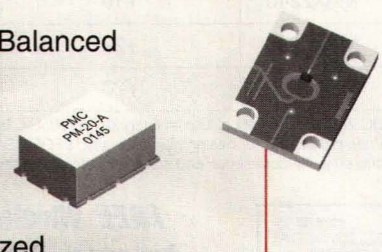

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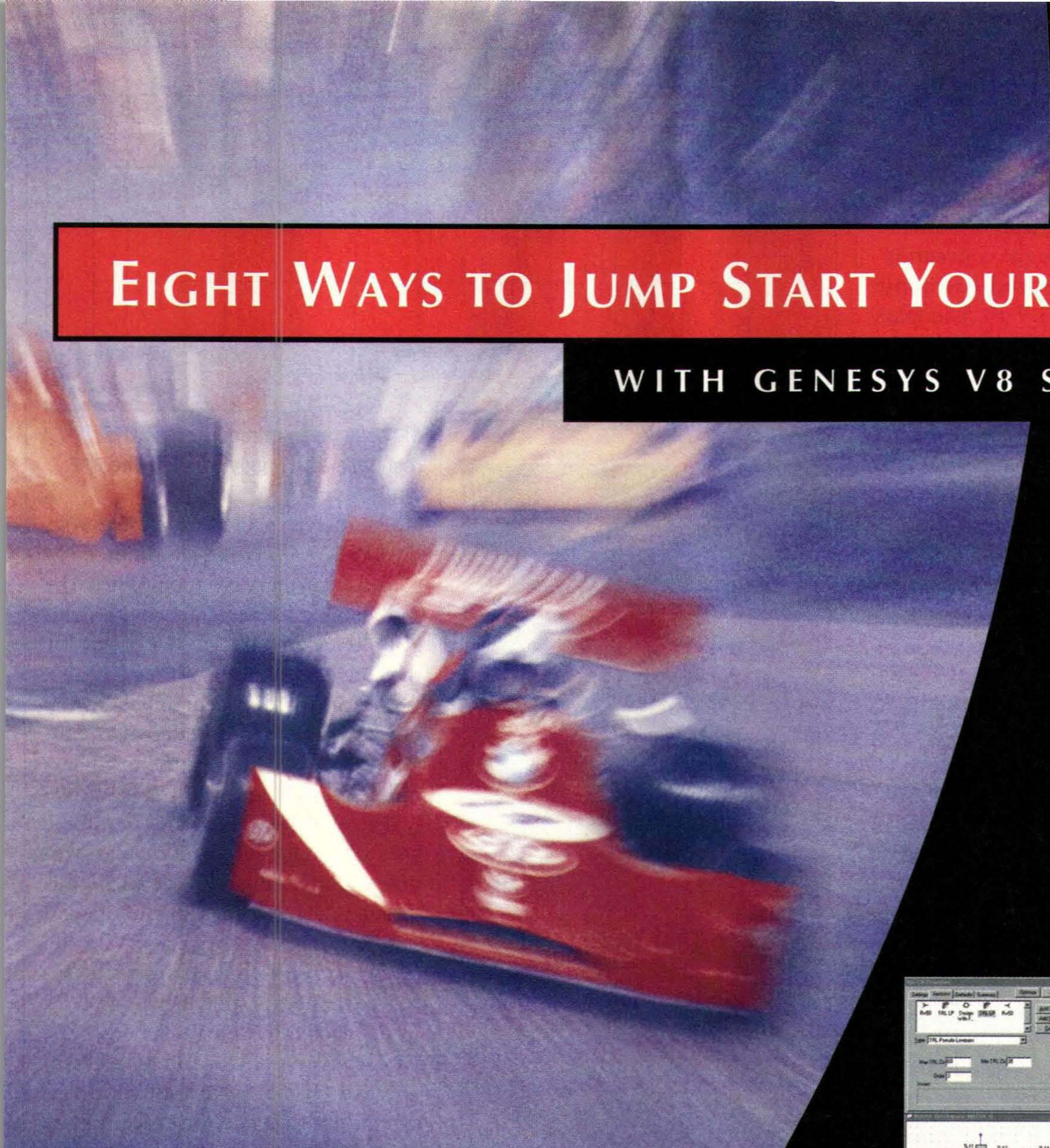

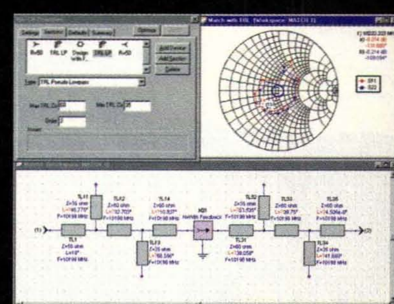

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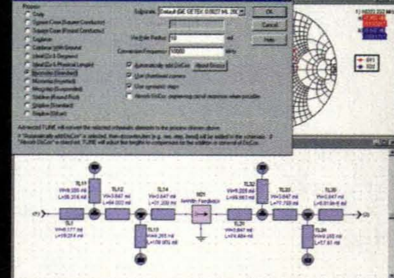

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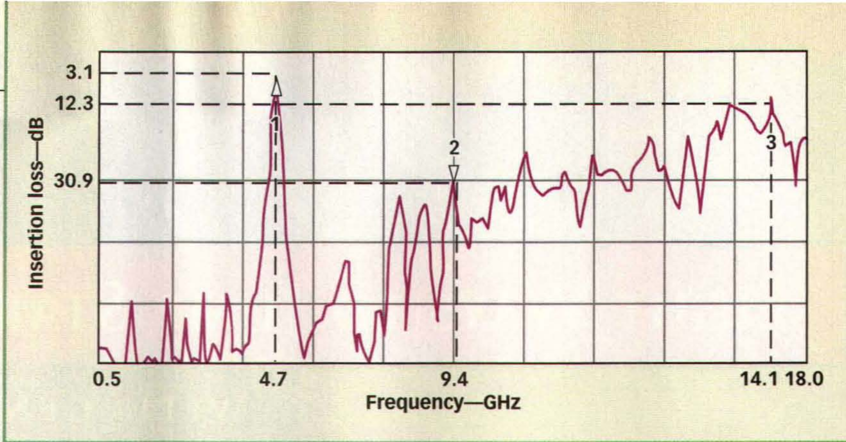
coupled-line BPF provides significantly improved second-harmonic attenuation of 95 dB, while the conventional BPF provides second-harmonic attenuation of only 3.9 dB. Bandpass losses for the microstrip wiggly BPF are less than 2 dB (Fig. 5b). The 30-dB attenuation level of the microstrip wiggly BPF is 9.5 percent, as compared to 12 percent in the conventional filter. The 3-dB level is 4.4 percent using the wiggly filter, compared to 5 percent for the conventional BPF.



6. These measurements show the response of a wiggly coupled-line BPF.

Performance measurements of the microstrip filter indicated that attenuation at the second and the third harmonics was 31 and 13 dB, respectively **(Fig. 6)**. **Table 1** illustrates harmonic attenuation for the experimental two-pole wiggly coupled-line BPF with different relative length of the opened stub, l/Λ, where Λ is the guide wavelength.

The substrate material for the filters in these experiments was TLE 95 from Taconic Plastics (Petersburg, NY), with thickness of 0.010 in. (0.254 cm) and dielectric constant of 2.95. Measurements of filter performance indicate that attenuation levels at the second and third harmonics were greater than 40 and 39 dB, respectively. **Table 2** illustrates simulation results for the parameters of the wiggly coupled-line BPF with zero and eighth-wavelength opened stubs. MRF

REFERENCES

1. G.L. Matthaei, L. Young, and E.M. Jones, *Microwave Filters, Impedance-Matching Networks and Coupling Structures*, McGraw-Hill, New York, 1964.
2. S.B. Cohn, "Shielded Coupled-Strip Transmission Line," *IEEE Transactions on Microwave Theory and Techniques*, Vol. MTT-3, October 1955, pp. 29-38.
3. L.G. Maloratsky, *Microminiaturization of Microwave Elements and Devices*, Soviet Radio, Moscow, 1976.
4. L.G. Maloratsky, "Design Regular- And Irregular-Print Coupled Lines," *Microwaves & RF*, September 2000, pp. 97, 98, 100, 102, 105, 106.
5. S. Cohn, "Parallel Coupled Line Resonator Filters," *IEEE Transactions on Microwave Theory and Techniques*, Vol. MTT-6, No. 2, April 1958, pp. 223-231.
6. A. Riddle, "High Performance Parallel Coupled Microstrip Filters," *IEEE MTT-S Digest*, 1988, pp. 427-430.
7. R.K. Hoffmann, *Handbook of Microwave Integrated Circuits*, Artech House, Norwood, MA, 1987.
8. T. Koryu Ishii, Ed., *Handbook of Microwave Technology*, Academic Press, New York, 1995.
9. L.G. Maloratsky, *Microstrip Resonators And Coupled Line Bandpass Filters Using Same*, US Patent No. 6,252,476, June 26, 2001.

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Design An Analog GSM Handset Power-Control Loop

Two challenges associated with GSM system design are overcoming PA output variations as a result of power-supply deviations and temperature changes.

Power-amplifier control (PAC) for a Global System for Mobile Communications (GSM) radio is one of the more challenging areas in GSM system design. Not only must the radio meet all output RF spectrum specifications, but the PAC loop must also be stable under varying environmental conditions. By understanding how to apply basic control theory to these designs, however, engineers can better ap-preciate the advantages of closed-loop systems over simple open-loop controls. What follows is a summary of a more complete and comprehensive article with full mathematical derivations that are available on the *Microwaves & RF* website at www.mwrf.com. The full version of this article includes a review of each block of the closed loop, an examination of stability issues, and a case study of a full GSM radio design.

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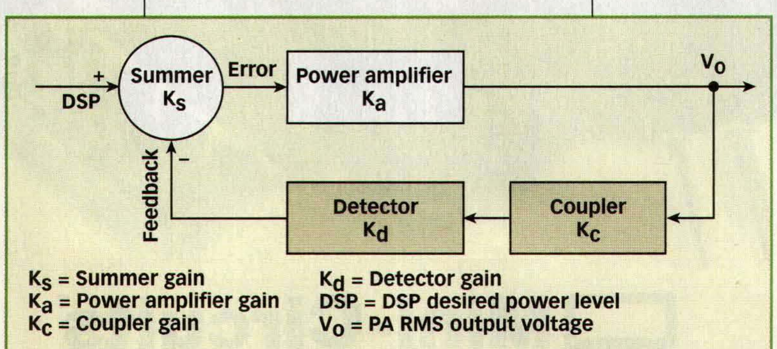
In a typical PAC loop using proportional control **(Fig. 1)**, the control signal is proportional to the difference between the detector/coupler feedback and the digital signal processor (DSP). This approach is known as a proportional control scheme because the output voltage, V_o, is directly proportional to the error signal. The closed-loop gain is divided into a forward-path gain (A) and a feedback-path gain (B) **[Fig. 2]**. The PA output power is a function of the feedback gain and the PA gain, which is sensitive to temperature and power-supply variations.

Closed-loop control has many advantages over open-loop control systems. For example, if the loop gain in a closed-loop system remains greater than zero, then the output voltage becomes insensitive to temperature and power-supply (battery) fluctuations. Although not obvious, the closed loop will track the DSP signal. Once the system reaches steady state, the feedback signal should be nearly identical to the DSP



1. A typical PAC loop with proportional control uses RF detector feedback to adjust PA output power.

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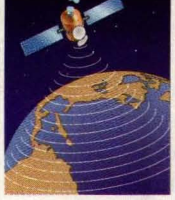

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Model	Freq (MHz)	Gain (typ) Midband (dB)	Gain (typ) Flat (±dB)	Max. P_{out}[1] (dBm)	Dynamic Range (Typ @2GHz[2]) NF(dB)	Dynamic Range (Typ @2GHz[2]) IP3(dBm)	I(mA)[3]	Price $ea. (1-9)
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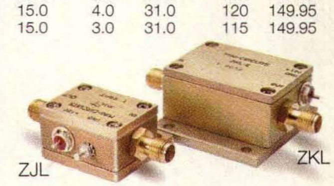
ZJL-7G	20-7000	10.0	±1.0	8.0	5.0	24.0	50	99.95
ZJL-4G	20-4000	12.4	±0.25	13.5	5.5	30.5	75	129.95
ZJL-6G	20-6000	13.0	±1.6	9.0	4.5	24.0	50	114.95
ZJL-4HG	20-4000	17.0	±1.5	15.0	4.5	30.5	75	129.95
ZJL-3G	20-3000	19.0	±2.2	8.0	3.8	22.0	45	114.95
ZKL-2R7	10-2700	24.0	±0.7	13.0	5.0	30.0	120	149.95
ZKL-2R5	10-2500	30.0	±1.5	15.0	5.0	31.0	120	149.95
ZKL-2	10-2000	33.5	±1.0	15.0	4.0	31.0	120	149.95
ZKL-1R5	10-1500	40.0	±1.2	15.0	3.0	31.0	115	149.95

NOTES:
1. Typical at 1dB compression.
2. ZKL dynamic range specified at 1GHz.
3. All units at 12V DC.



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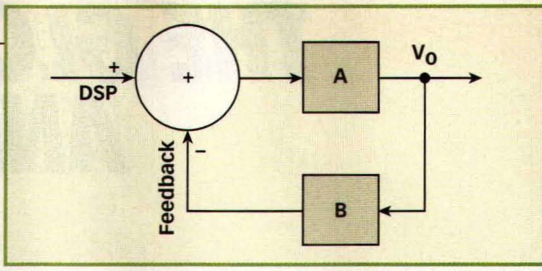
signal. At a loop gain of greater than 1, the feedback signal approximates the DSP signal.

Most PAC loops employ an integrator in the control-loop forward path, which changes the topology from one of proportional control to one of integral control **(Fig. 3)**. The control voltage driving the PA is the integral of the error. The integrator output provides the correct control voltage to the PA by integrating past errors. By using an integrator, the PA gain is essentially removed from loop steady-state operation. As long as the feedback gain remains the same, the integrator will drive the PA to the calibrated power level.



2. In a closed-loop control system, A represents forward-path gain and B is feedback-path gain.

In theory, integral control has the advantage that the loop can settle to a condition of zero error. But the integrator approach also has several drawbacks. If there are any conditions where the PA cannot meet the calibrated output-power level, the loop will drive the PA into saturation. This, in turn, can cause problems for switching transients. Also, the integrator adds a phase shift or delay of 90 deg. to the loop, so careful attention must be paid to stability.

A PAC loop includes several key components, including an RF detector and a coupler. The RF detector converts an output voltage scaled value into a DC voltage used for comparison with the DSP value. The detector should be temperature compensated and remain stable under all operating conditions. Several types of RF detectors are candidates for a PAC loop, including passive single-diode detectors, temperature-compensated passive dual-diode detectors, and active temperature-compensated dual-diode detectors. A diode detector functions as a simple half-wave rectifier. The detection function occurs when the peak RF voltage is greater than the detector diode's "on" voltage. The detector's output voltage is nearly a linear function of the applied peak RF voltage. (For the sake of calculations, an RMS voltage value at the input of a diode detector can be converted to peak voltage via multiplication by √2.) Since the detector operates at a high frequency of 900 to 1800 MHz, it is important that the diodes to be used are capable of switching at this speed. The diode of choice has usually been the Schottky, with its ability to switch extremely fast. The Schottky also has a low on voltage of

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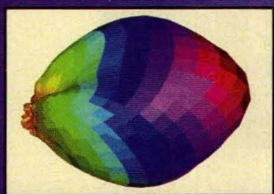

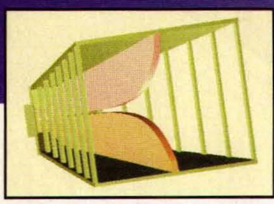

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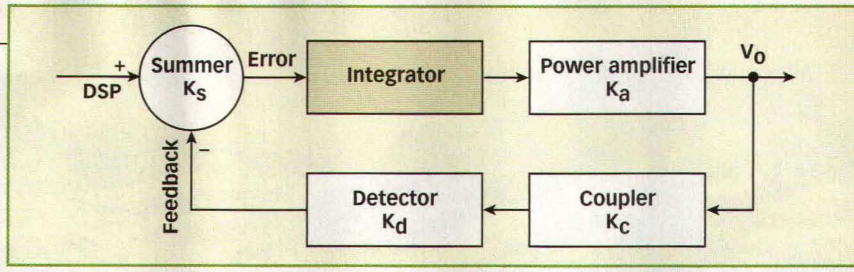
approximately 200 mV typical, which helps to extend the lower range of the detector.

Temperature-compensated passive dual-diode detectors overcome the temperature-dependence limitations simple passive diode detectors. The active dual-diode detector, in turn, has a major advantage over the passive dual-diode detector. At low temperatures, the active detector does not drop off like the passive detector. An active detector can operate well at −20 to +20 dBm over a wide temperature range.



3. Integral control can be implemented in a PAC loop by adding an integrator to the loop's forward path.

The coupler is a passive temperature-stable device that is suitable for a feedback block. The amount of coupling not only defines dynamic range, but also limits the minimum insertion loss in the output path. Generally, couplers are found in the range of 10 to 20 dB, with the least amount of coupling being preferred for insertion loss. The amount of coupling also defines the amount of feedback gain and limits the maximum amount of loop gain.

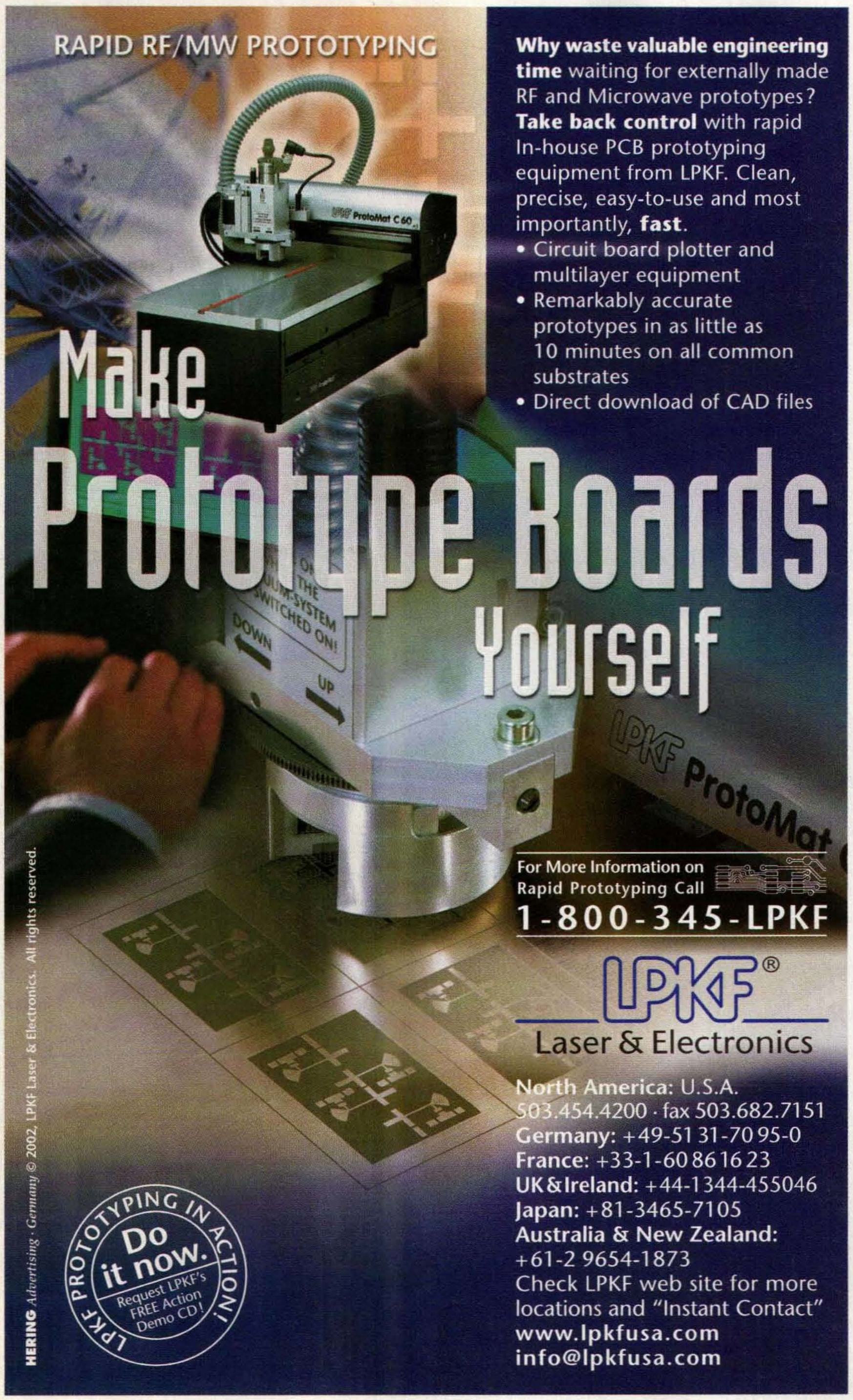
When selecting a dual-band coupler for a PAC loop, several factors should be considered, including the coupler's insertion loss, the minimum and maximum power of each band, the dynamic range of the detector, the difference between the minimum power levels of each band, and the minimum detectable power (which is related to the dynamic range of the detector). Also, the coupler should not be overdriven at high power levels.

For more about designing analog PAC loops for GSM applications, please refer to the full-length version of this article on the *Microwaves & RF* website at www.mwrf.com. The longer version includes full derivations of loop functions and error calculations, techniques for measuring the gain and phase margins of a PAC loop, and a case study of a dual-band GSM/digital-communications-services (DCS) handset design. The test case is based on the use of a model CX77301 amplifier from Conexant Systems (Newport Beach, CA). MRF

FOR FURTHER READING

Paul R. Grey and Robert G. Meyer, *Analysis and Design of Analog Integrated Circuits,* Wiley, New York, 1993.

Gene F. Franklin, J. David Powell, and Abbas Emami-Naeini, *Feedback Control of Dynamic Systems,* Addison-Wesley, Reading, MA, 1991.



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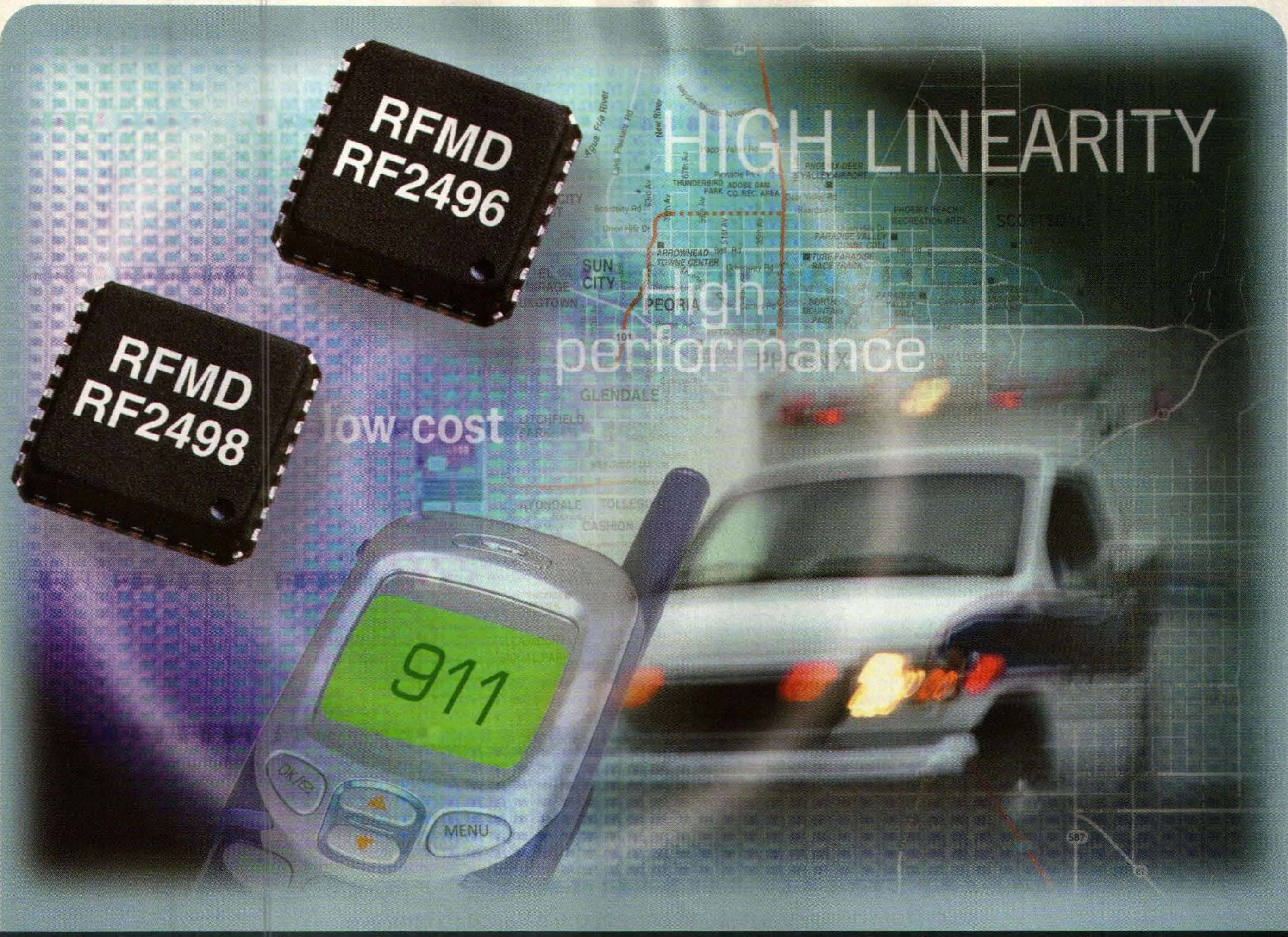

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IIP3 (dBm)	+9 (LNA)	+11 (Cell LNA) +8 (PCS LNA)	-9.0 (Cell)/-8.5 (PCS) Cascaded results for RX path	+11 (Cell LNA)/+8 (PCS LNA)/ +3 (GPS LNA)
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Balanced LNA Suits Cellular Base Stations

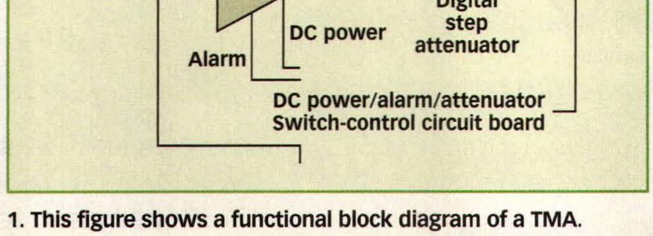
A TMA installed beneath a base-station antenna can increase that base station's range to 40 percent as the TMA corrects the common cellular problem of link imbalance.

Base stations can often transmit a signal to a mobile handset further and stronger than they can receive the return signals. This is known as link imbalance and it is made worse by the feeder loss between the base station and the antennas. The imbalance can be as high as 20 percent or more, so system designers need to correct the balance to improve coverage. The simplest solution is the addition of a tower-mounted amplifier (TMA) or masthead amplifier.

A TMA installed directly beneath a base-station antenna can increase the sensitivity of the base station and increase its range to 40 percent, correcting the link imbalance and practically doubling its reception coverage area. A low-loss filter and low-noise amplifier (LNA) within the TMA help to select and amplify the received signal.

A typical TMA functional block diagram is shown in **Fig. 1**. The alarm circuit senses a failure in the LNA and is normally triggered by a window comparator circuit that checks the bias current. The bypass switch permits bypass of the LNA if a failure occurs and, thus, allows the base-station sector to keep operating, but with reduced performance. The switch can be implemented with PIN or field-effect-transistor (FET) devices. The LNA to be described covers 1.7-to-2.2-GHz applications.

The primary goals for any LNA are low noise figure, adequate gain, and stability. For the tower-mounted application, a high intercept point, +5-VDC supply voltage, and low current consumption are also required. The use of a balanced configuration supports good input and output match, and helps



1. This figure shows a functional block diagram of a TMA.

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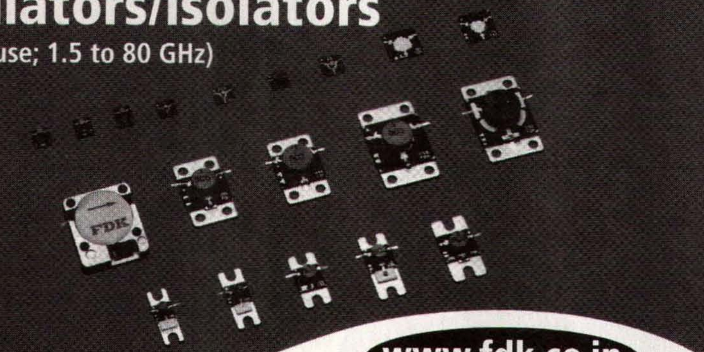

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ensure stability. However, the splitter/combiner network must maintain low loss, be physically small, and have good phase and amplitude balance over the bandwidth of interest. Also, the bandwidth should be high enough to include the uplink (mobile-handset-to-base-station) frequencies for cellular standards of approximately 2 GHz. The design goals were thus chosen, as shown in **Table 1.**

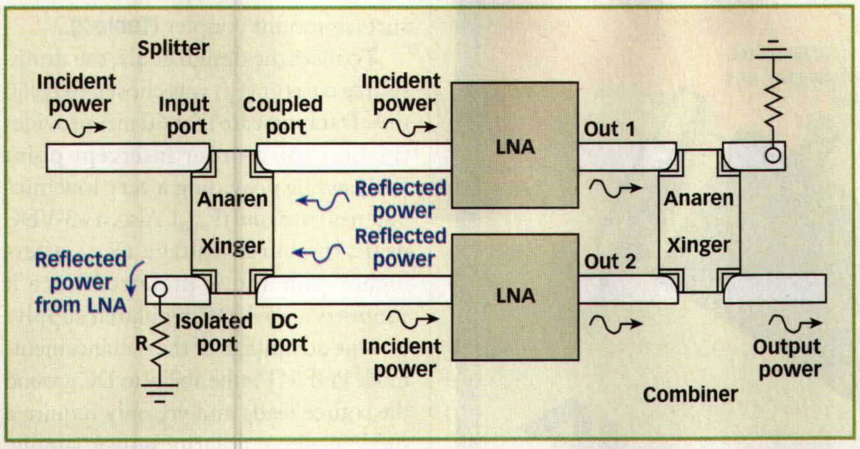
A critical first step in any LNA design is the selection of the active device. Low-cost FETs are often used for their low noise figures and high linearity.

Besides maintaining a low typical noise figure of 0.5 dB, Agilent Technologies' (Santa Clara, CA) ATF-54143 uses a +3-VDC bias and provides a +36-dBm intercept point at 60-mA drain current. In addition, the ATF-54143 is an enhancement-mode device and, thus, does not require a negative gate voltage.

The ATF-54143 is one of a family of new high-dynamic-range, low-noise enhancement-mode pseudomorphic-high-electron-mobility-transistor (PHEMT) devices designed for low-cost commercial applications in the very-high-frequency (VHF)-to-6-GHz frequency range. It has an 800-µm gate-width device with 2-GHz performance tested and guaranteed at a V_{ce} of +3 VDC and I_d of 60 mA. If an active bias is desirable for repeatability of the bias setting, then the ATF-54143 will only require the addition of a single PNP BJT.[1]

An important consideration for a balanced amplifier is the splitting and combining of the RF signal. When designing the splitter network for a balanced LNA, there is interest in minimizing insertion loss and return loss while providing equal power to both amplifiers. Power dividers are sometimes used for this task. The most popular types are the T-junction divider and Wilkinson power divider. Wilkinson power dividers use quarter-wavelength transmission lines to produce desired power splits. Due to the quarter-wavelength transmission lines, the bandwidth of a single section power divider is limited to 10 to 20 percent.

Although power dividers can be used in balanced amplifier design, low-loss



2. Reflective power from each of the two identical LNA inputs (shown in blue) recombines at the isolated port of the hybrid coupler, and is dissipated in the resistive termination.

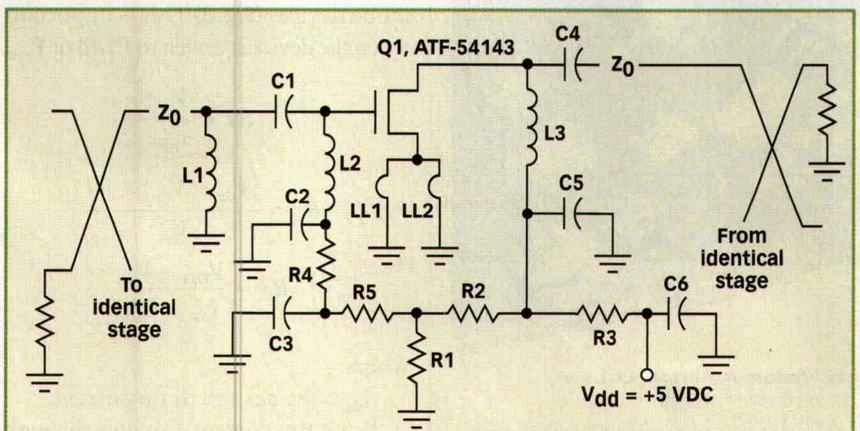
hybrid couplers are superior. Hybrid couplers are four-port devices that have good match and isolation with a fixed 90-deg. phase shift between output ports. The bandwidth of a branch-line hybrid is limited to 10 to 20 percent, but a single-section broadside coupler can have a bandwidth as large as an octave.

Figure 2 illustrates the most important advantage of using a hybrid coupler over a power divider on the input side of the balanced amplifier. Reflected power from each of the two identical LNA inputs (shown in blue) recombines at the isolated port of the hybrid coupler, and is dissipated in the resistive termination. This allows one to design each LNA for optimum noise-figure performance without worrying about return loss from each of the two LNAs. If a hybrid coupler is used on the input side, then an identical hybrid coupler can be used on the output side to recombine the signals.

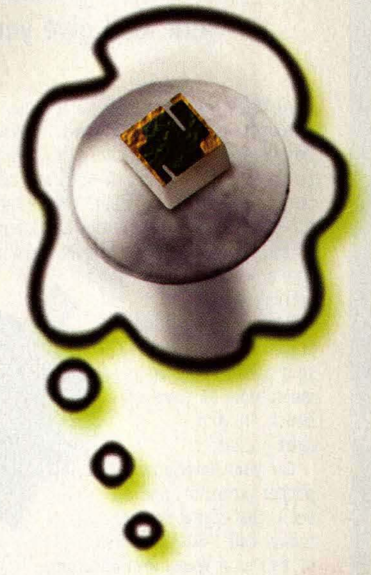
Anaren Microwave, Inc. (Syracuse, NY) recently released a new class of miniature hybrid couplers known as Pico Xingers®. The chosen balanced amplifier was the Pico Xinger JP503

Table 1: Design goals

PARAMETER AT 2000 MHZ	VALUE
Gain	15.5 dB
Noise figure	0.8 dB
Output third-order intercept point	+39 dBm
Input third-order intercept point	+23.5 dBm
Output P1dB compression	+22.4 dBm
Input return loss	25 dB
Output return loss	27 dB
Supply current	120 mA
Bandwidth	1.7 to 2.2 GHz



3. The amplifier schematic is shown here.



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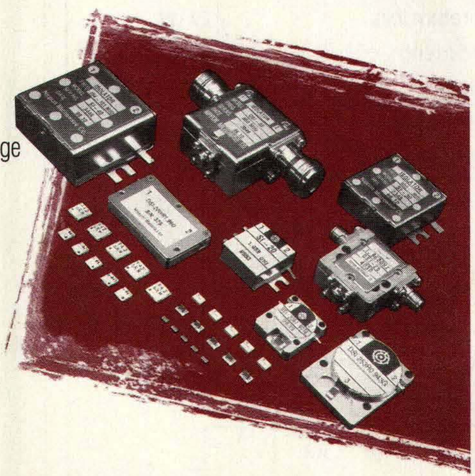

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surface-mount coupler **(Table 2)**.

To meet the design goals, the drain-source current (I_{ds}) was chosen to be 60 mA. Data indicate that 60 mA provides the best third-order intercept point (IP3), while providing a very low minimum noise figure (F_{min}). Also, a +3-VDC drain-to-source voltage (V_{ds}) offers higher gain and is preferred since it supports a +5-VDC regulated supply.

One advantage of the enhancement-mode PHEMT is the ability to DC ground the source leads and yet only require a single positive-polarity power supply. A depletion-mode PHEMT pulls maximum drain current when $V_{gs} = 0$ VDC, whereas an enhancement-mode PHEMT pulls approximately zero drain current when $V_{gs} = 0$ VDC. The gate must be made positive with respect to the source for the enhancement-mode PHEMT to begin pulling drain current. Also note that if the gate terminal is left open-circuited, the device will pull some amount of drain current due to the leakage current, creating a voltage differential between the gate and source terminals.

ATF-54143 biasing is accomplished with a voltage divider, consisting of R1 and R2. The voltage is derived from the drain voltage which provides a form of voltage feedback to help keep drain current constant. The purpose of R4 is to enhance the low-frequency stability of the device by providing a resistive termination at low frequencies. Capacitor C3 provides a low-frequency bypass for R4. Additional resistance in the form of R5 is added to provide current limiting for the gate of enhancement-mode devices **(Fig. 3)** This is important when the device is driven to P1dB or P_{sat}.

$$R1 \approx \frac{V_{gs}}{I_{BB}}$$

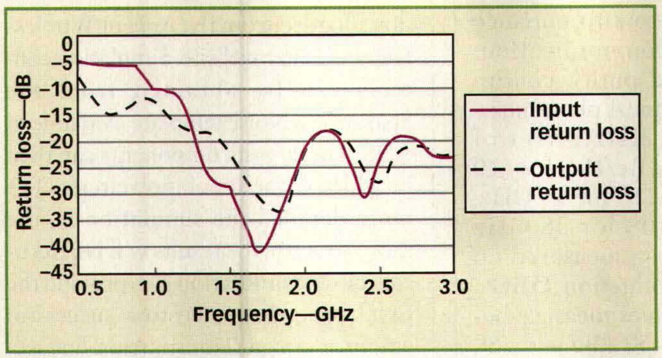
$$R2 \approx \frac{\left(V_{ds} - V_{gs}\right) \times R1}{V_{gs}}$$

$$R3 \approx \frac{V_{DD} - V_{ds}}{I_{ds} + I_{BB}}$$

where:

I_{ds} = the desired drain current,

I_{BB} = the current flowing through the R1/R2 voltage divider network,



4. The linear-simulated input and output return loss versus frequency is illustrated.

V_{DD} = +5 VDC,
V_{ds} = +3 VDC,
I_d = 60 mA,
V_{gs} = +0.56 VDC,
R1 = 280 Ω,
R2 = 1220 Ω, and
R3 = 32.3 Ω.

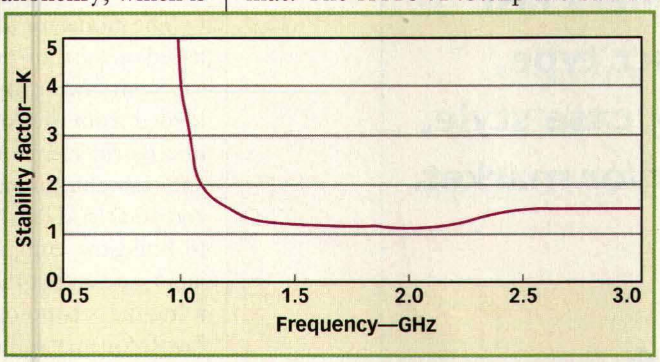
The repeatability of the bias settings from device to device is a function of a particular device's DC characteristics. More information on this can be found in ref. 1.

The use of a controlled amount of source inductance can often be used to enhance LNA performance. The amount of inductance required is usually only a few tenths of a nanohenry, which is equivalent to increasing the source leads by approximately 0.05 in. The effect can be modeled using an RF simulation tool such as Agilent Technologies' Advanced Design System (ADS). The usual side effect of excessive source inductance is VHF gain peaking with resultant oscillations. Larger gate-width devices have less high-frequency gain and, therefore, the high-frequency performance is not as sensitive to source inductance as a smaller device would be.

Using EEsof ADS software, the amplifier circuit can be simulated in linear and nonlinear modes of operation. The original design draft was an LNA with an OIP3 of +39 dBm with an approximate noise figure of 1 dB at 2 GHz.

Linear Analysis

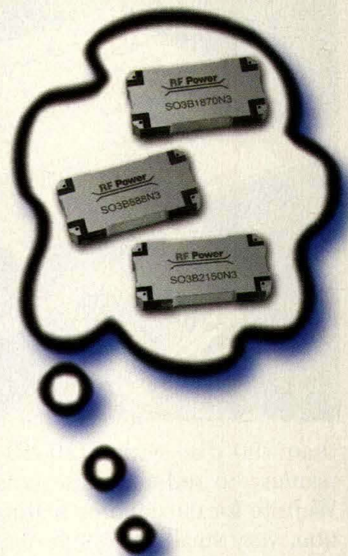
One half of the amplifier circuit used for linear analysis is shown in **Fig. 5.** For linear analysis, the transistors can be modeled with a two-port scattering (S)-parameter file using Touchstone™ format. The ATF54143.s2p file can be



5. A plot of the Rollett Stability factor (K), as calculated from 1 to 3 GHz, is shown here for the amplifier.

Table 2: Data for the JP503

SPECIFICATION	BANDWIDTH	UNITS
Frequency	2.0 to 2.3	GHz
Isolation	20	dB minimum
Insertion loss	0.30	dB maximum
VSWR	1.20	maximum: 1
Amplitude balance	±0.25	dB maximum
Phase balance	3	deg. maximum
Power handling	25	avg. watts—CW max.



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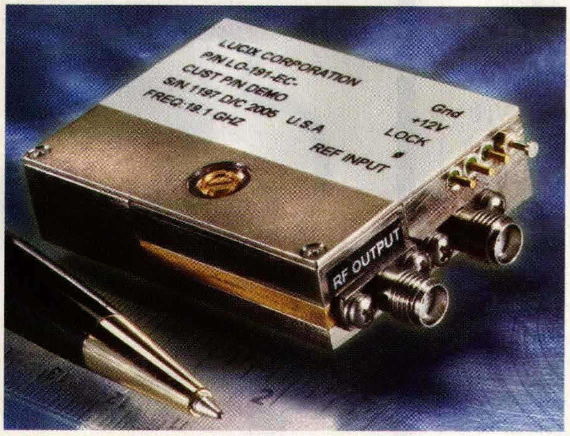

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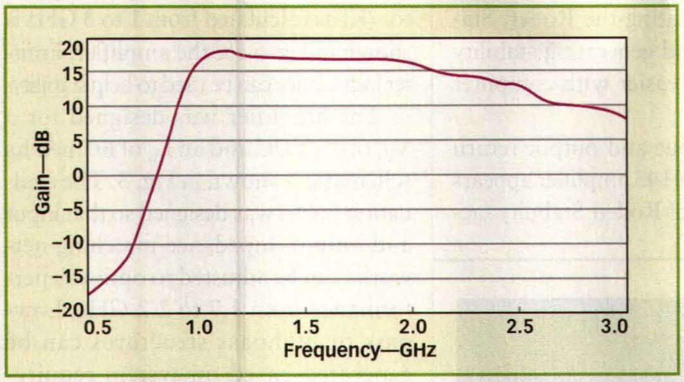
downloaded from the Agilent Wireless Design Center website. Simulation controls can be obtained from the Sparams_wNoise template available in ADS. The circuit components can then be added to the simulation circuit. The more detailed the simulation is, the more accurate the results will be. Accurate circuit simulation can provide the first appropriate step to a successful amplifier design. Transmission-line sections can be modeled with various microstrip and stripline elements available in the component library. In this case, all microstrip sections assumed a 0.031-in.-thick board and FR-4 material. Inductance associated with the chip capacitors and resistors was also included in the simulation. Where possible, models were chosen from the ADS SMT component library. Models of SMT components can also be obtained from the manufacturers web sites. Manufacturing tolerances in active and passive components often prohibit perfect correlation. When the design met the specifications for gain, noise figure, and stability, the create/edit schematic symbol function was used, allowing designers to duplicate the amplifier design.

The model for the hybrid coupler is based on the four-port Touchstone linear S-parameter file and can be downloaded from the Anaren website. The microstrip elements, the circuit-balanced amplifier input and output tracks, and 50-Ω load resistor pads were added to build the complete amplifier. The input- and output-matching network use a highpass topology to ensure good low-frequency stability. The simulator is then used to find component values, which provide the desired performance.

Results of simulated input and output return losses are shown in **Fig 4**. The linear-simulated performance of the amplifier was very close to the measured results. The design was tested with a +3-VDC, 40-mA S-parameter file and did not show any change in linear performance.

The ATF-54143 S- and noise parameters are tested in a fixture that includes plated through holes through a 0.025-



6. The measured gain of the completed amplifier is seen here.

in.-thick printed-circuit board (PCB). Due to the complexity of de-embedding these grounds, the S- and noise parameters include the effects of the test-fixture grounds.

Therefore, when simulating a 0.031-in.-thick PCB, the only difference in the PCB thickness is included in the simulation (i.e., 0.031 – 0.025 in. = 0.006 in.). The transmission lines that connect each source lead to its corresponding plated through hole are simulated as a microstrip transmission line (MLIN).

Nonlinear Analysis

For nonlinear analysis, harmonic-balance simulation was used. Harmonic balance is preferred over other nonlinear methods because it is computationally fast, handles distributed- and lumped-element circuitry, and can easily include higher-order harmonics and intermodulation (IM) products.[2]

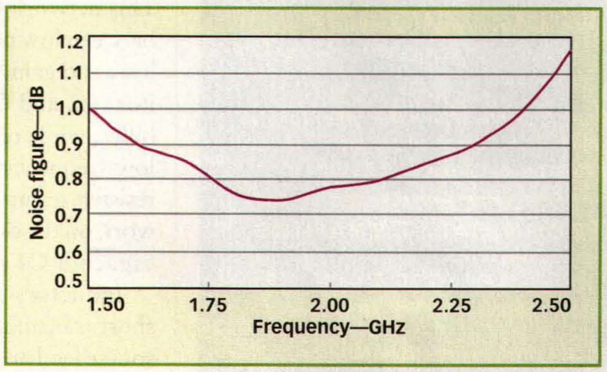
The nonlinear transistor model used in the simulation is based on the work of Curtice.[3] The model can be downloaded from Agilent's website or by request from the authors. An important feature of the nonlinear model is the use of a quadratic expression for the drain current versus gate voltage. Although this model closely predicts the DC and small-signal behavior (including noise), it does not predict the intercept point correctly. For example, the balanced output third-order intercept point (OIP3) was simulated at +34.4 dBm and the P1dB was at +21.8 dBm. The simulated performance for P1dB was very close to the measured results. However, the simulated OIP3 was too low. To properly model the exceptionally high linearity of the EPHEMT transistor, a better model is needed. This model, however, can still be used to predict the relative importance of output matching, bias, and source inductance.

Circuit Stability

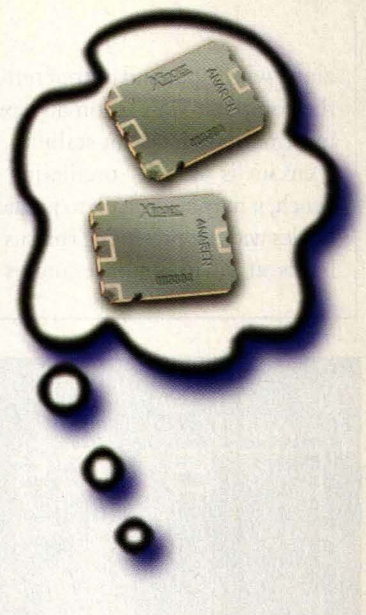
Besides providing important information regarding gain, P1dB, noise figure,

Table 3: Measured results

PARAMETER	VALUE
Minimum gain	14.8 dB
Maximum noise figure	0.85 dB
Output third-order intercept point	+39 dBm
Input third-order intercept point	+24.2 dBm
Output P1dB compression	+22.4 dBm
Maximum input return loss	17.2 dB
Maximum output return loss	18.5 dB
Supply current	120 mA
Bandwidth	1.7 to 2.2 GHz



7. Noise figure is a nominal 0.8 dB from 1.7 to 2.1 GHz.



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along with input and output return loss, the computer simulation also provides information on circuit stability. Unless a circuit is actually oscillating on the bench, it may be difficult to predict instabilities without presenting various VSWR loads at various phase angles to the amplifier. Calculating the Rollett Stability factor K and generating stability circles are made easier with computer simulations.

Simulated input and output return loss of the ATF-54143 amplifier appears in Fig. 4. A plot of Rollett Stability factor (K) as calculated from 1 to 3 GHz is shown in Fig. 5 for the amplifier. Emitter inductance can be used to help stability.

The amplifier was designed for a V_{ds} of +3 VDC and an I_{ds} of 60 mA. Its schematic is shown in Fig. 3. The evaluation board was designed so that input and output impedance-matching networks can be adjusted to optimize performance from 1.7 to 2.2 GHz. Lowpass or highpass structures can be generated based on system requirements. The main constraint for the LNA RF layout is that the circuit must be a balanced configuration. The effect of uneven path lengths results in the summing of the signals out of phase and lower output power and IP3 than expected. To achieve a balanced configuration, the bottom ATF-54143 is turned through 90 deg., supporting an easy duplication of the top and bottom RF microstrip tracks.

The amplifier uses a highpass impedance-matching network for the noise match. The highpass network consists of a series capacitor C1 and shunt inductors L1 and L2. The circuit loss will be directly related to noise figure. A Toko America, Inc. (Mt. Prospect, IL) LL1608-FS4N7 multilayer chip inductor or similar device is suitable for this purpose. Shunt inductor L1 provides low-frequency gain reduction, which can minimize the amplifier's susceptibility to low-frequency transmitter (Tx) overload. It is also part of the input-matching network along with C1. C1 also doubles as a DC block. L2 doubles as a result of inserting gate voltage for biasing up the PHEMT. This requires a good bypass capacitor in the form of C2. This network has been a compromise between low noise figure, input return loss, and gain. Resistor R2 and capacitors C2 and C4 provide in-band stability, while resistors R1 and R3 offer low-frequency stability by providing a resistive termination. The highpass network on the output consists of a series capacitor C4 and shunt inductor L3.

Inductors LL1 and LL2 are very short transmission lines between each source lead and ground. The inductors act as series feedback. The amount of

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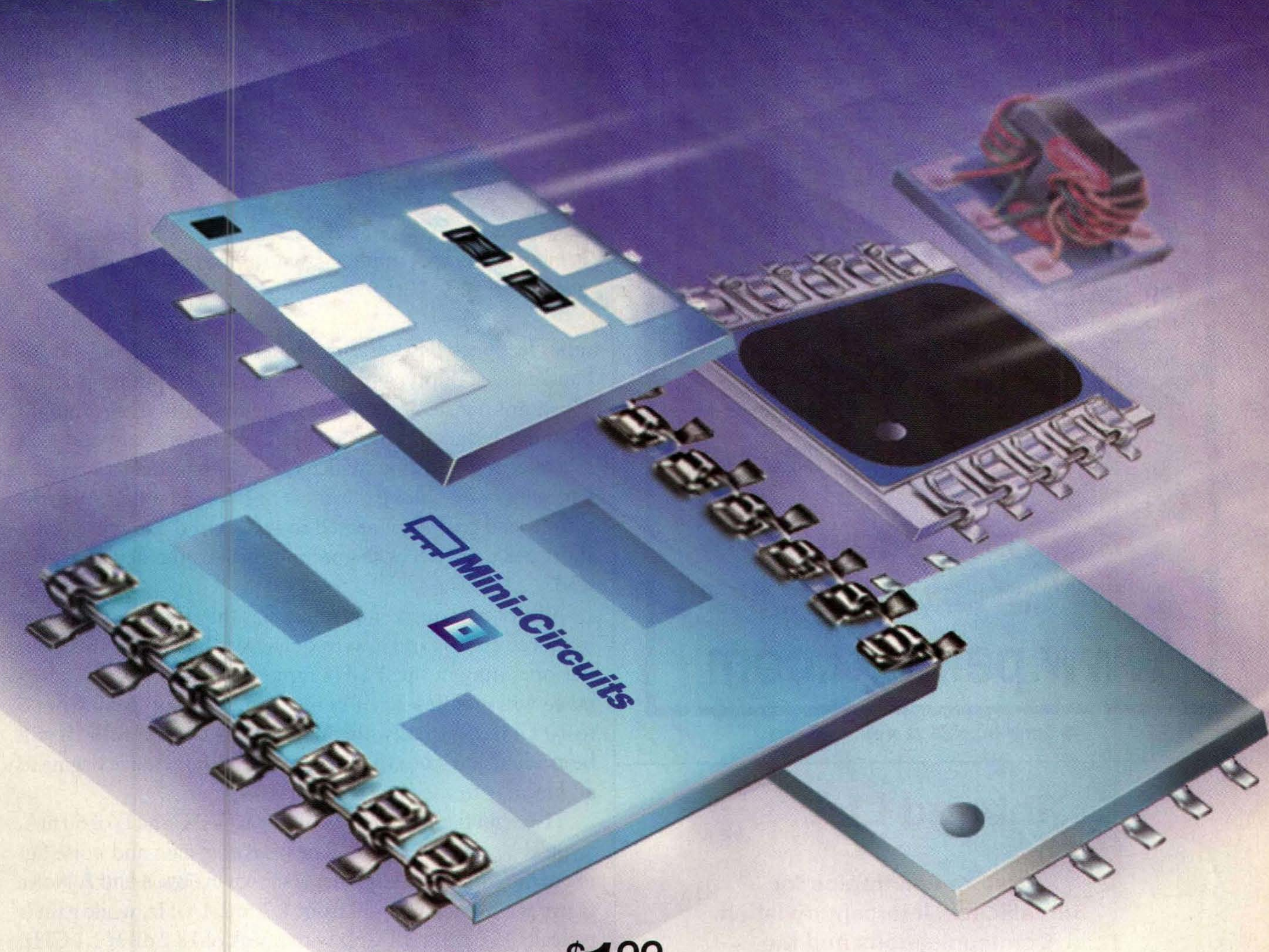

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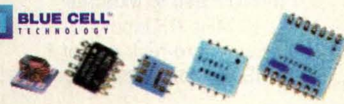

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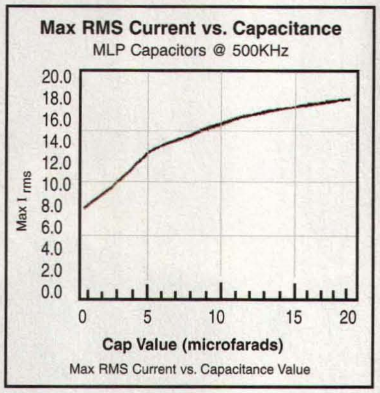

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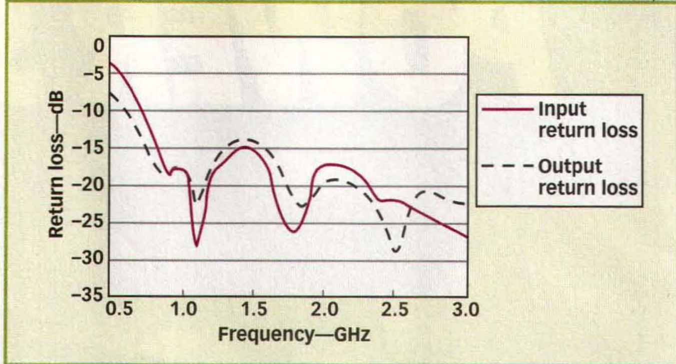

8. Input and output return loss versus frequency can be seen above.

series feedback has a dramatic effect on in-band and out-of-band gain, stability, as well as input and output return loss. The amplifier demo board is designed so that the amount of source inductance is variable. Each source lead connects to a microstrip section, which can be connected to a ground pad at any point along the line. For minimal inductance, the source lead pad is connected to the ground pad with a very short piece of etch at the point closest to the device source lead.

Additional source inductance has the effect of improving input return loss and low-frequency stability. For an amplifier operating in the 2-GHz range, excessive source inductance will manifest itself in the form of a gain peak from 6 to 10 GHz. Normally, the high-frequency gain roll-off will be gradual and smooth. Adding source inductance begins to add bumps to the once smooth roll-off.

The amplifier is biased at a V_{ds} of +3 VDC and I_d of 60 mA. Typical V_{gs} is +0.56 VDC. The measured gain and noise figure of the completed amplifier is shown in **Figs. 6 and 7**. Noise figure is a nominal 0.8 dB from 1.7 to 2.1 GHz, while gain is typically 15.3 dB at 2.1 GHz with a peak of 18.2 dB at 1.1 GHz. Noise-figure performance was found to be slightly better than the simulated noise figure of the circuit **(Table 3)**.

Measured input and output return loss are shown in **Fig. 8**. The input return loss at 2 GHz is 17.3 dB with a corresponding output return loss of 20 dB. The amplifier output IP3 was measured at a nominal +39 dBm at a DC bias point of +3 VDC V_{ds} and an I_d of 60 mA. P1dB measured +22.4 dBm. The amplifier was also checked at lower bias conditions of +3 VDC V_{ds} and I_d of 40 mA. No degradation to the noise and gain response was noted. Typical output IP3 was measured at a nominal +36 dBm. MRF

REFERENCES

1. Applications Note (AN1222): High intercept Low Noise Point Amplifier for 1850 to 1910 MHz PCS Band using the ATF-54143 Enhancement Mode PHEMT, A.J. Ward.
2. Stephan Maas, *Nonlinear Microwave Circuits*, IEEE Press, New York, 1997.
3. W.R. Curtice, "A MESFET Model For Use In The Design Of GaAs Integrated Circuits," *IEEE Transactions On Microwave Theory Techniques*, Vol. MTT-28, pp. 448-456, May 1980.

ACKNOWLEDGEMENTS

Special thanks to Mark Bowyer (Anaren) for suggesting this work and Alan Rixon (Agilent) for his many useful comments on TMA system requirements.

NOTE

Performance data for ATF-54143 PHEMT may be found on www.agilent.com/view/rf. Application notes can be found at: www.anaren.com and www.agilent.com/view/rf.

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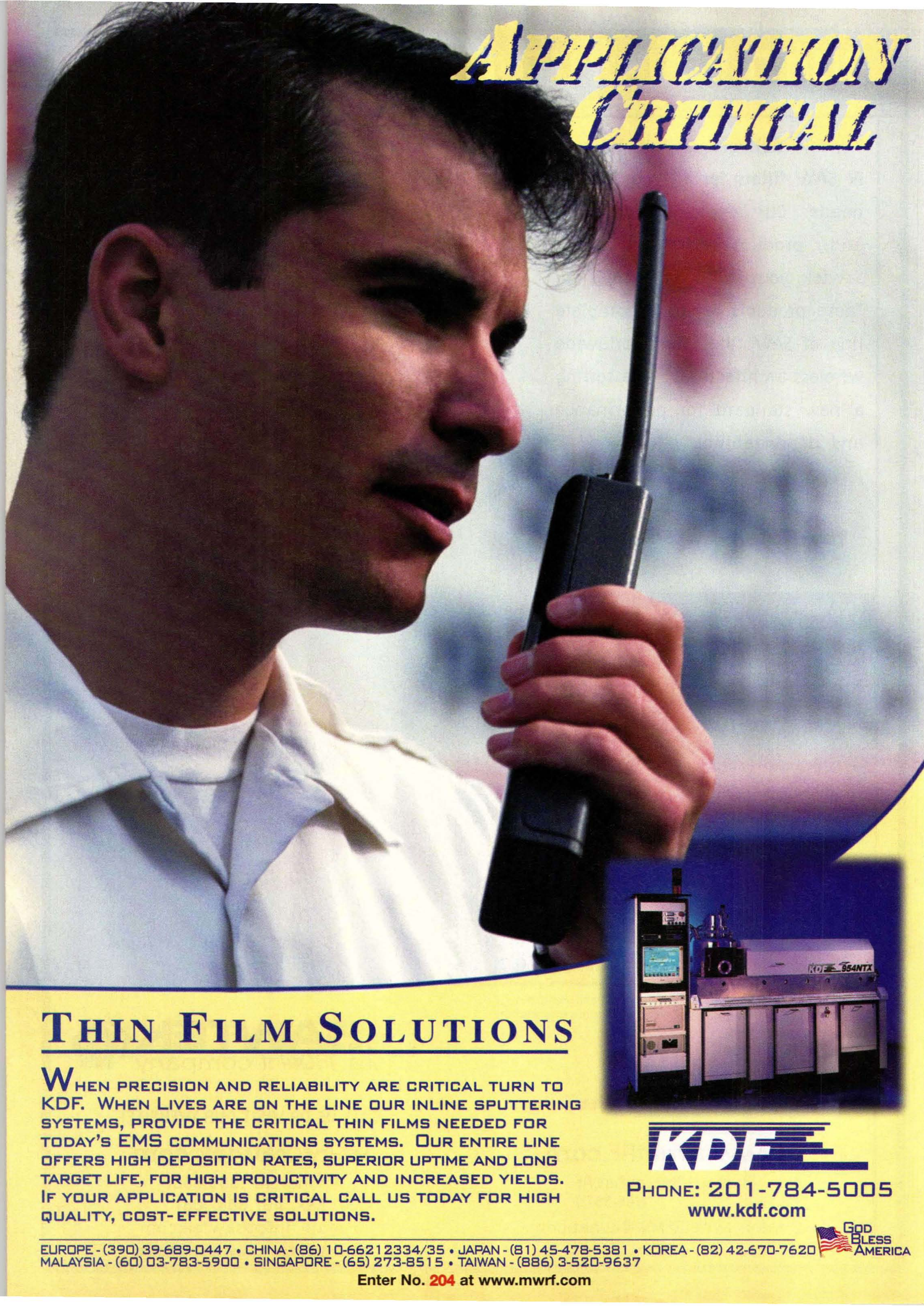

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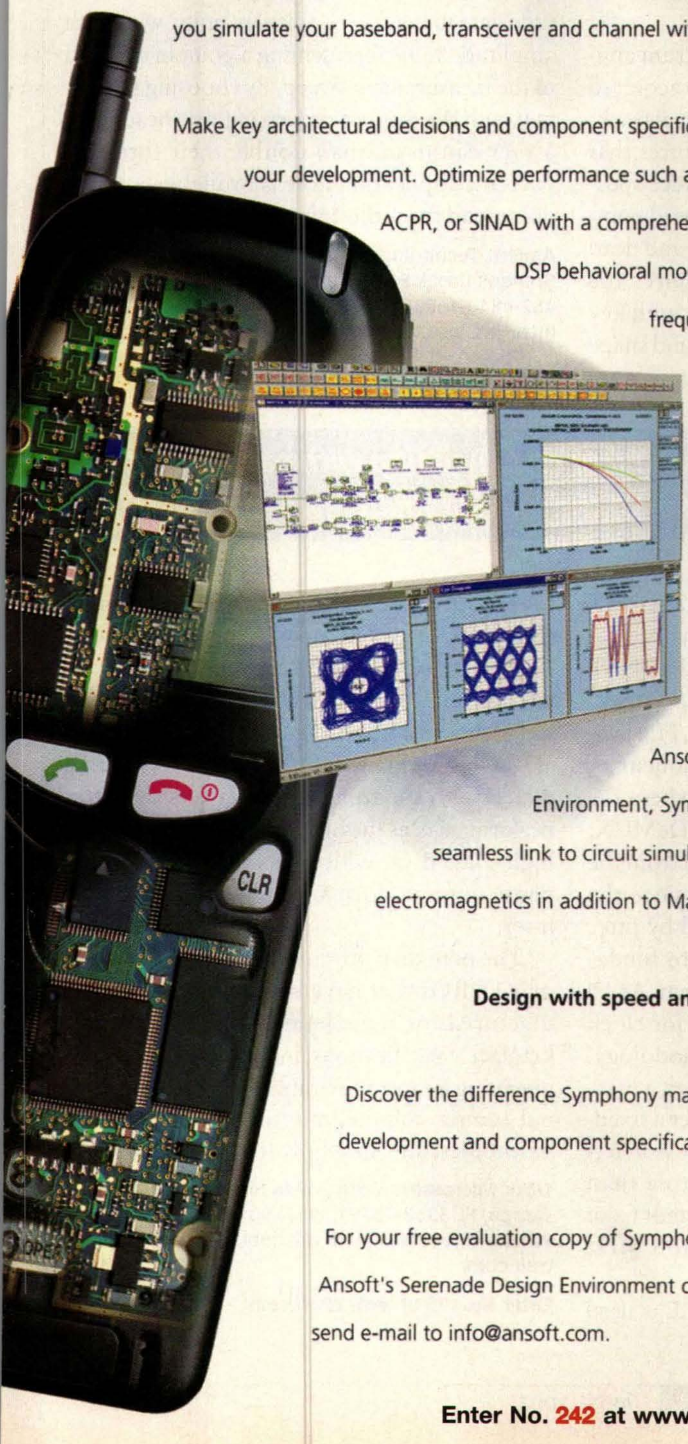

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Determine spectrum-analyzer time requirements

SPECTRUM ANALYZERS ARE used to provide signal measurements in a plethora of situations, including component testing during the manufacturing process, field analysis of malfunctioning equipment, and prototype testing at the R&D stage. It is therefore imperative that a spectrum analyzer operate at optimum speed. An eight-page application note from Agilent Technologies (Santa Clara, CA), entitled "Speeding Up Spectrum Analyzer Measurements," explores spectrum-analyzer speed issues and identifies several time components that are essential to a user choosing a spectrum analyzer that will enhance their productivity.

While many engineers desire spectrum analyzers to provide more analysis on the acquired data, including markers, averaging, signal tracking, and ACP, these are the very features that increase processing overhead and reduce spectrum-analyzer speed. Three major speed components as warmup time, sweep time, and dead time. Sweep-time optimization requires the selection of the optimum RBW filter, with key specifications to consider being width and shape factor. A digital RBW filter, used in conjunction with FFT, which calculates the spectrum through ADCs that sample the last IF, can make measurements in the narrowest RBW settings in 330 ms, or more than 50 times faster.

For standalone operation, instantaneous response is desire, so the update rate should be between 25 and 30 continuous measurements per second, which minimizes any time delay between a manual adjustment and the updated spectrum-analyzer display. For remote operation, the extra step of formatting data for export increases processing time and slows the update rate. Spectrum analyzers offer amplitude data in machine or display units, with each amplitude value representing a point in the span of the measurement sweep. By choosing the format with the shortest processing-overhead time, a user can more than double their throughput.This application note is available as a free download from the company's website.

Agilent Technologies, Test & Measurement, 5301 Stevens Creek Blvd., Santa Clara, CA 95052; (800) 452-4844, (650) 752-5000, FAX: (650) 752-5633, Internet: www.agilent.com.

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Spectrum analyzers offer amplitude data in machine or display units, with each amplitude value representing a point in the span of the measurement sweep.

VTDROs target low-jitter SONET applications

THE USE OF VTDROs in 10-Gb/s OC-192 SONET and SDH systems is the subject of an application note entitled "Low-Jitter, OC-192 SONET Voltage-Tuned Dielectric Resonator Sources" from TRAK Microwave Corp. (Tampa, FL). Synchronization is an important component of SONET/SDH systems. In a system where the data stream is transponded or MUX/DeMUX, the embedded clock must be removed from the stream without jitter being added, since the quality of the signal source is judged by jitter amount. Low-jitter clock sources are fundamental for any communications system. At 10 Gb/s and beyond, it is much harder for clock jitter to gauged by traditional methodology. In these cases, jitter is described through a measurement of integrated phase noise over a fixed-offset bandwidth. Phase noise at the close-in frequencies plays a more significant role than phase noise at frequencies that are distant from the carrier. Phase noise from 50 kHz to 1 MHz is integral to jitter performance.

In the majority of systems, the PLL is used to regenerate the main, synchronous, and subordinate clocks that are used in that location. The PLL's VCO must be reliable, have low jitter, and a linear control characteristic because its function is integrated into MUX/DeMUX ICs at10 Gb/s and beyond. A hybrid VCO with a dielectric resonator provides excellent jitter performance, as the dielectric resonator ensures high loaded Q, which in turn provides low phase-noise performance and, therefore, low jitter.

The note then offers specifications for a line of VTDROs that have been specifically manufactured for the commercial SONET marketplace. Specifications, including package size, operating temperature range, phase noise, external tuning voltage, modulation bandwidth, harmonics, and supply voltage, are covered.

TRAK Microwave Corp., 4726 Eisenhower Blvd., Tampa, FL 33634-6391; (813) 901-7200, FAX: (813) 901-7491, e-mail: tmc@trak.com, Internet: www.trak.com.

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Model	Freq. ■ (MHz)	Gain (dB) 0.1GHz	Gain (dB) 2GHz	Flatness† DC-2GHz (dB)	Max. Power Out▲ @1dB Comp. (dBm)	Dynamic Range▲ NF (dB)	Dynamic Range▲ IP3 (dBm)	Thermal Resist. θjc, °C/W	DC Operating Power Current (mA)	DC Operating Power Volt	Price $ea. (25 Qty.)
Gali 1	DC-8000	12.7	11.8	±0.5	12.2	4.5	27	108	40	3.4	.99
Gali 21	DC-8000	14.3	13.1	±0.6	12.6	4.0	27	128	40	3.5	.99
Gali 2	DC-8000	16.2	14.8	±0.7	12.9	4.6	27	101	40	3.5	.99
Gali 33	DC-4000	19.3	17.5	±0.9	13.4	3.9	28	110	40	4.3	.99
Gali 3	DC-3000	22.4	19.1	±1.7	12.5	3.5	25	127	35	3.3	.99
• Gali 6F	DC-4000	12.1	11.6	±0.3	15.8	4.5	35.5	93	50	4.8	1.29
• Gali 4F	DC-4000	14.3	13.4	±0.5	15.3	4.0	32	93	50	4.4	1.29
• Gali 51F	DC-4000	18.0	15.9	±1.0	15.9	3.5	32	78	50	4.4	1.29
• Gali 5F	DC-4000	20.4	17.4	±1.5	15.7	3.5	31.5	103	50	4.3	1.29
• Gali 55	DC-4000	21.9	18.5	±1.7	15.0	3.3	28.5	100	50	4.3	1.29
• Gali 52	DC-2000	22.9	17.8	±2.5	15.5	2.7	32	85	50	4.4	1.29
• Gali S66	DC-3000	22	17.3	±2.4	2.8	2.7	18	136	16	3.5	.99
Gali 6	DC-4000	12.2	11.8	±0.3	18.2	4.5	35.5	93	70	5.0	1.49
Gali 4	DC-4000	14.4	13.5	±0.5	17.5	4.0	34	93	65	4.6	1.49
Gali 51	DC-4000	18.1	16.1	±1.0	18.0	3.5	35	78	65	4.5	1.49
Gali 5	DC-4000	20.6	17.5	±1.6	18.0	3.5	35	103	65	4.4	1.49

■ Low frequency cutoff determined by external coupling capacitors. † Measured in test fixture P/N 90-6-20-26.
▲Models tested at 2GHz except Gali 4, 5, 6, 51, 52, 6F, 4F, 51F, 5F at 1GHz.
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cover story

MMIC Amps Add Gain And Isolation

This series of fully integrated amplifiers operate with a fixed voltage source and minimal external components while providing high isolation in compact, low-profile packages.

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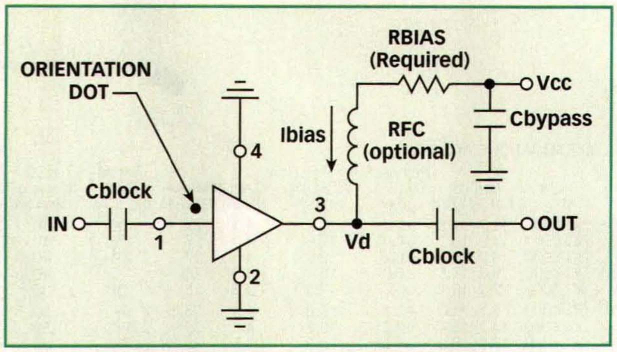
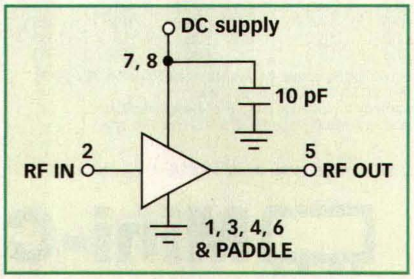
Mini-Circuits, P.O. Box 350166, Brooklyn, NY 11235; (718) 934-4500, FAX: (718) 332-4661, Internet: www.minicircuits.com.

Monolithic-microwave-integrated-circuit (MMIC) amplifiers were first developed as convenient gain blocks for circuits requiring a boost in signal level. Although MMIC amplifiers may contain several transistor stages and impedance-matching circuits, most still require a considerable number of supporting external components for proper operation. To simplify the use of MMIC amplifiers, Mini-Circuits (Brooklyn, NY) has developed the MNA series of high-isolation, low-profile amplifiers for applications from 0.5 to 5.9 GHz with gain levels from 12 to 22 dB. The only external component needed is a low-value bypass capacitor for DC bias filtering.

Conventional MMIC amplifiers are designed for fixed-current operation, even though this is sometimes difficult to achieve in applications with low-voltage supplies. A constant-current source can be approximated with additional circuit elements, although this requires a voltage source, RF choke (inductor), and

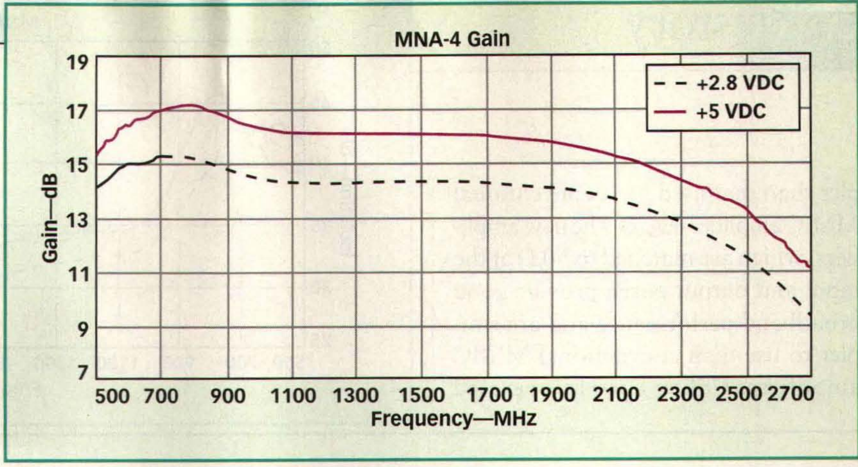


1. The biasing circuit of most monolithic microwave amplifiers is shown here.



2. The biasing circuit of a new MNA series monolithic amplifier requires fewer external components.

3. The low-cost MNA amplifiers are supplied in a surface-mount package.



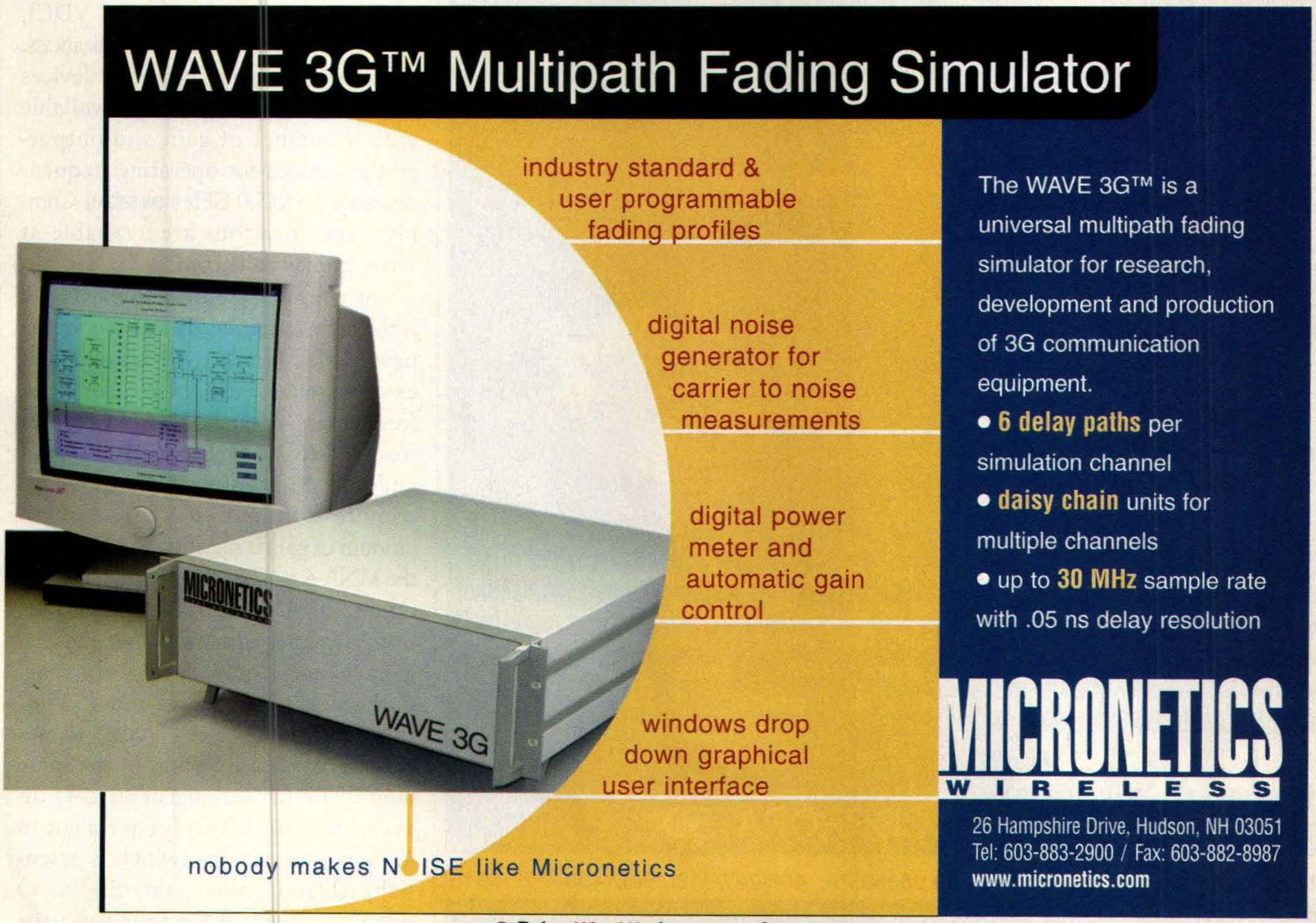
4. The gain performance of the MNA-4 was measured at +2.8 and +5.0 VDC.

resistor. In addition, DC-blocking capacitors are needed at the input and output ports of many MMIC amplifiers. These additional circuit elements not only add cost to a design, but size on a printed-circuit board (PCB). The MNA series amplifiers simplify PCB design by operating with a fixed voltage source, thus eliminating most of the external components found with a conventional MMIC amplifier. Besides being easy to use, these amplifiers feature a low package profile and extremely high isolation. The MNA can be used in circuits where broadband active isolation is needed.

In a conventional fixed-current MMIC amplifier, DC bias current is applied at the RF output terminal **(Fig. 1)**. Due to this application, it is important to ensure that the biasing circuit does not load the RF output port. This can be done by carefully selecting the RF choke (RFC) and the bias resistor, R_{bias}, and making sure that the DC current does not go to the RF load (the DC current can be effectively blocked by them, blocking capacitor, C_{block}).

To prevent a reduction in gain and output power, the combined reactance of RFC and R_{bias} should be greater than 500 Ω. Also, the resonant frequency of the RF choke should be higher than the amplifier's intended frequency of operation. In addition, a DC-blocking capacitor is needed at the input to prevent DC-current flow back into the signal source. A minimum of +2-VDC drop across R_{bias} is required for proper operation.

In contrast, the biasing configuration for the new MNA amplifiers is much sim-



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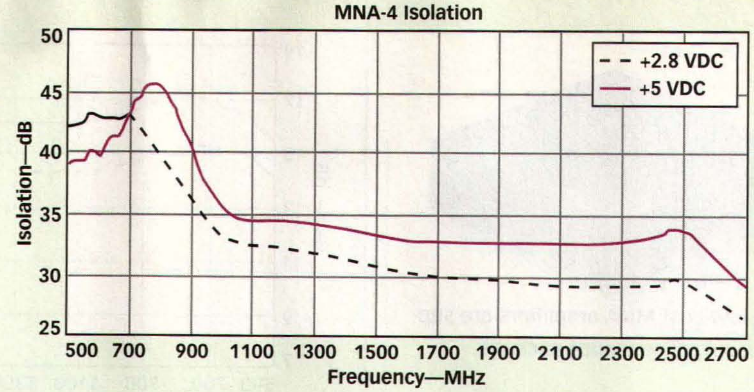
pler than that used for a conventional MMIC amplifier **(Fig. 2).** The new amplifiers, which are matched to 50 Ω at the input and output ports, provide good broadband performance and are simpler to use than conventional MMIC amplifiers. Unlike current-operated amplifiers, the MNA series amplifiers features separate terminals for the RF output and DC supply.



5. The isolation of the MNA-4 amplifier was measured at +2.8 and +5.0 VDC.

The MNA series amplifiers are housed in a miniature surface-mount package measuring only 3 × 3 × 0.89 mm for a significant savings in PCB space compared to existing MMIC amplifiers **(Fig. 3).** The MNA amplifiers include a bottom paddle, which is soldered directly to a user's PCB to provide low thermal resistance. Because the MNA amplifiers can be operated over a wide range of voltages (from +2.8 to +5.0 VDC), they are useful for a variety of applications, including in battery-powered devices Currently, seven models are available with a number of gain and output-power options for operating frequencies from 0.5 to 5.0 GHz **(see table).** Complete specifications are available at www.minicircuits.com.

As an example, the model MNA-7 is the highest-frequency member of the new MMIC family, with a range that extends from 1.5 to 5.9 GHz. For lower frequencies, model MNA-4 operates from 0.5 to 2.5 GHz with 16-dB gain and +17-dBm output power at 1-dB compression and +5 VDC. A small amount of gain is sacrificed by operating the MNA-4 at +2.8 VDC, while still maintaining high isolation and good output-power performance. Note that the gain change is only 2 dB for the drastic change of supply voltage from +5 VDC to +2.8 VDC **(Fig. 4). Figure 5** shows that the reverse isolation of the same amplifier is in the range of 30 to 45 dB across the band. This is equivalent to an active directivity (which is essentially isolation minus gain) of 15 to 30 dB, which enables these amplifiers to be used as low-cost active isolators.

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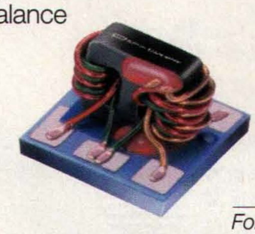

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SBTC-2-10-75	10-1000	75Ω	3.49
SBTC-2-15-75	500-1500	75Ω	3.49
SBTC-2-10-5075	50-1000	50/75Ω	3.49
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The MNA amplifiers at a glance

MODEL	FREQUENCY (GHz)	GAIN (dB)	1-dB COMPRESSION (dBm) AT +5 VDC	NOISE FIGURE	IP3 (dBm) AT +5 VDC	ISOLATION (dB)	CURRENT (mA) (TYPICAL)	PRICE QTY. 30 (US $)
MNA-1	0.5 to 2.5	12	+7	5.7	17	29 to 40	29	1.60
MNA-2	0.5 to 2.5	12	+17	8.0	27	30 to 46	69	1.90
MNA-3	0.5 to 2.5	15	+7	4.7	25	32 to 43	30	1.60
MNA-4	0.5 to 2.5	16	+17	4.8	29	32 to 44	75	1.90
MNA-5	0.5 to 2.5	21	+7	3.5	19	35 to 49	28	1.60
MNA-6	0.5 to 2.5	22	+17	3.1	27	32 to 47	72	2.25
MNA-7	1.5 to 5.9	17	+15.5	5.2	28.7	25 to 44	75	2.25

The input VSWR of the MNA-4 was measured at less than 1.80:1 at 900 MHz and +2.8 VDC and less than 1.40:1 at the same frequency and with operation from +5 VDC. At 1900 MHz, the input VSWR for the MNA-4 was less than 1.75:1 when running at +2.8 VDC and less than 1.30:1 when running at +5 VDC. The output VSWR of the MNA-4 was measured at less than 1.80:1 at 900 MHz and +2.8 VDC and less than 1.50:1 at the same frequency and with operation from +5 VDC. At 1900 MHz, the output VSWR for the MNA-4 was less than 1.75:1 when running at +2.8 VDC and less than 1.35:1 when running at +5 VDC.

Measurements of output power at 1-dB compression for the MNA-4 amplifier show that the trade-off of output power with supply voltage is well-defined. The difference between +2.8 and +5.0 VDC at lower frequencies is about 5 dB, while the difference between the two supply-voltage extremes is 2.5 dB at higher frequencies.

The thermal resistance of the MNA series amplifiers, from junction to case, is 780°C/W. For +17-dBm output MNA amplifiers, this results in a junction-temperature rise of 350°C above the case. At +850°C case temperature, the junction temperature is thus +1200°C. When soldered onto a PCB, the amplifier case temperature typically rises 100°C above ambient, making the junction temperature 1300°C. The mean time to failure (MTTF) is approximately 2000 years at this junction temperature. For lower-power MNA models, the junction temperature is even lower.

The MNA amplifiers are available from 0.5 to 5.9 GHz. They have a separate terminal for DC, and require no external matching, biasing, or DC-blocking elements. **Mini-Circuits, P.O. Box 350166, Brooklyn, NY 11235; (718) 934-4500, FAX: (718) 332-4661, Internet: www.minicircuits.com.**

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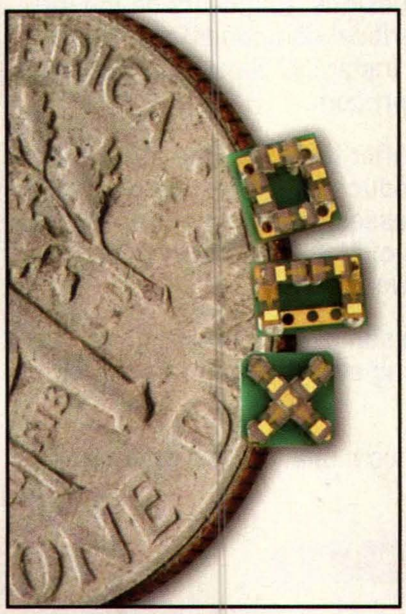

SPECIFICATIONS

Bandwidth:
100MHz – 6GHz
Isolation:
900 MHz (LMDS): 40 dB(typ.)
2400 MHz (PCS): 30 dB (typ.)
5600 MHz (WLAN): 20 dB (typ.)
Insertion loss:
900 MHz (LMDS): 0.25 dB (typ.)
2400 MHz (PCS): 0.5 dB (typ.)
5600 MHz (WLAN): 1.0 dB (typ.)
Power Handling:
10 Watts
Third order IP:
+39 dBm (typ.)
Switching speed:
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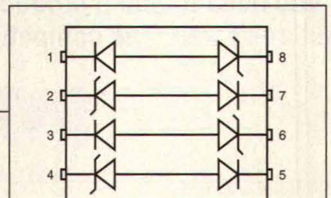

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- Temp Coefficient 3mV/°C max
- IEC-6000 ESD compliant

APPLICATIONS
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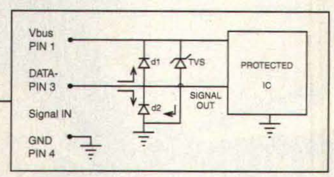
- Data line Protection



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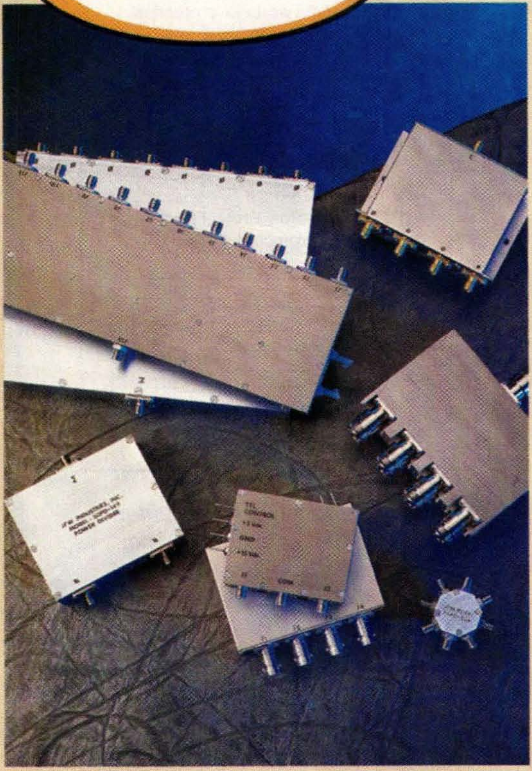

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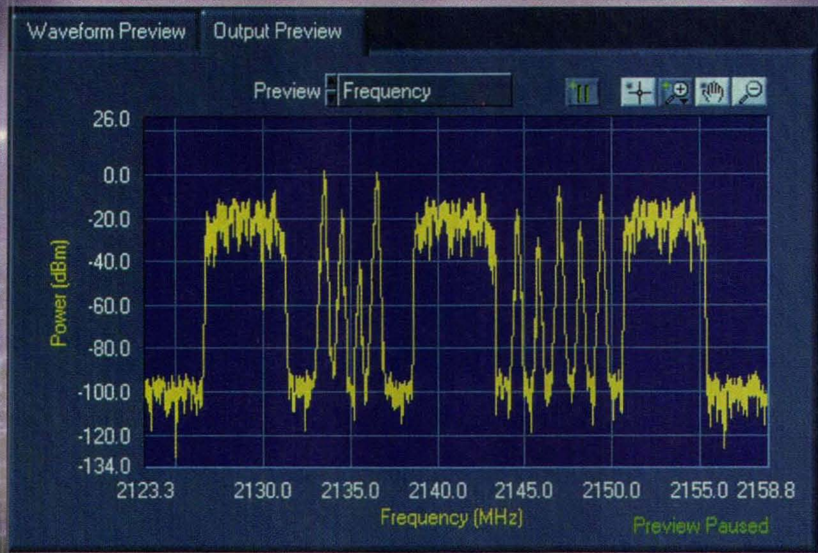

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CRU Recovers 40-Gb/s OC-768 Clock Signals

Based on a high-Q dielectric-resonator filter and carefully designed input data section, this clock-recovery unit provides low-jitter clock signals for high-speed OC-768 systems.

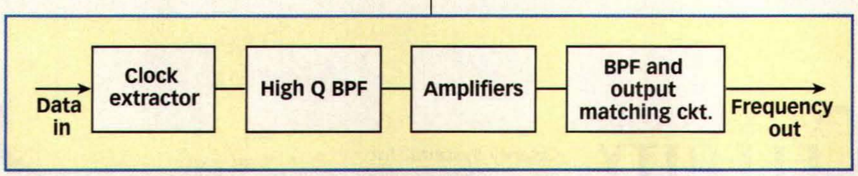
SUBBA KUNASANI, PH.D.
Senior Design Engineer
Communication Techniques, Inc., 9 Whippany Rd., Whippany, NJ 07981; (973) 884-2580, FAX: (973) 887-6245, e-mail: skunasani@cti-inc.com, Internet: www.cti-inc.com.

Clock recovery is an important function in fiber-optic datacommunications systems. In many networks, such as asynchronous transfer mode (ATM) and synchronous optical network (SONET) systems, data is transmitted without a clock or reference signal. To collect the data, a receiver (Rx) must first recover the clock signal to re-establish synchronous timing of the data. Especially for the high-speed OC-768/STM-256 systems operating at 40 Gb/s, clock recovery is a key performance parameter. What follows is an examination of a clock-recovery unit (CRU) based on a high-performance dielectric resonator filter.

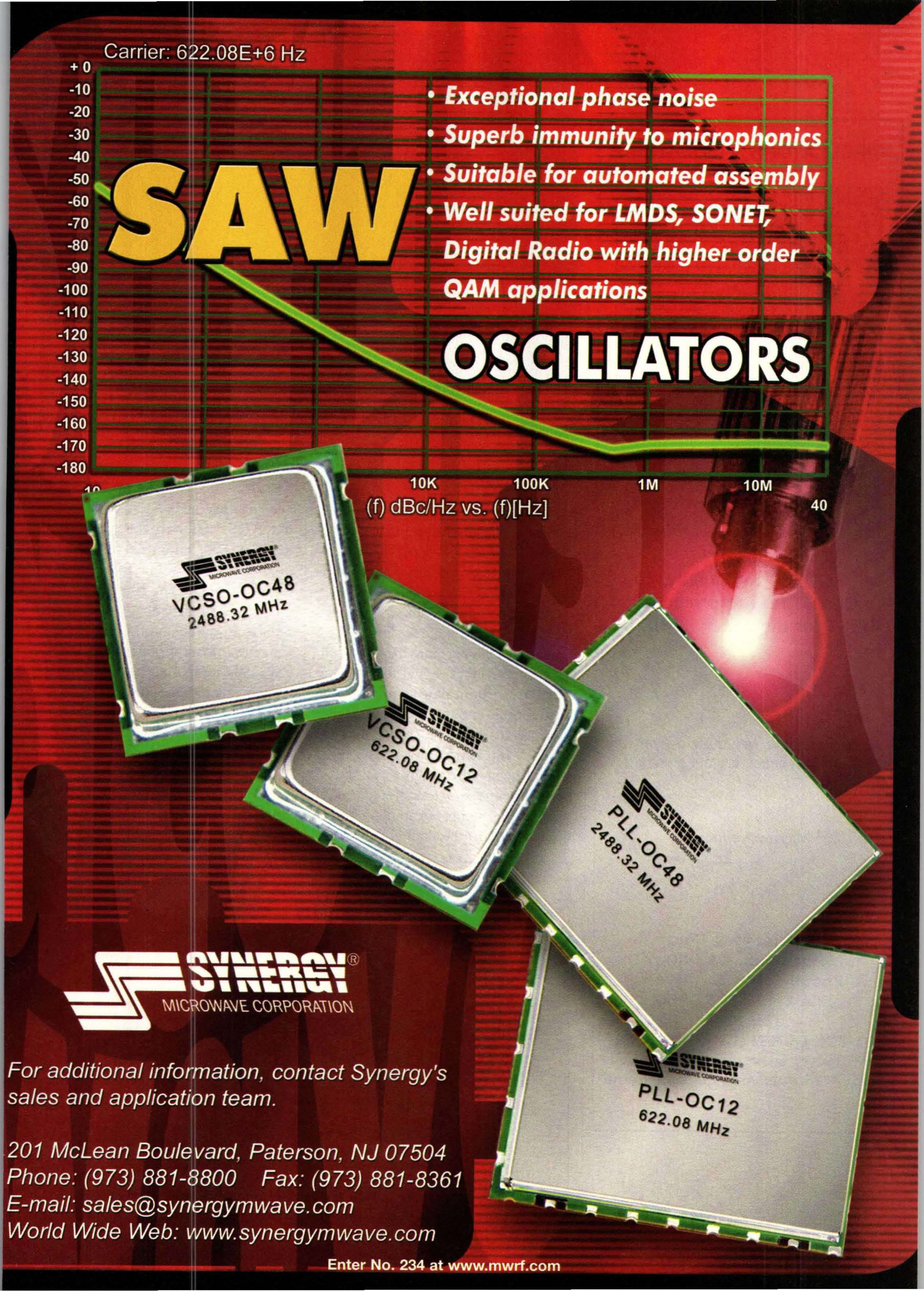
Some CRUs are based on the use of a phase-locked loop (PLL), which requires a sensitive phase detector and a fairly linear voltage-controlled oscillator (VCO) with low phase noise. Since the design of both is difficult, and a drawback of the PLL approach is the relatively long re-acquisition period when the data stream resumes after a dropout, Communication Techniques, Inc. (CTI; Whippany, NJ) chose to base its CR-40 OC-768/STM-256 CRU on a high-quality-factor (Q), single-pole dielectric-resonator filter **(Fig. 1)**.

In most cases, data transmissions for OC-48 (2.488 Gb/s) and OC-192 (9.953 Gb/s) systems are in the non-return-to-zero (NRZ) format. For long-haul applications, the RZ format may be more suitable for managing pulse spreading due to dispersion in the fiber-transmission medium. For 40-Gb/s OC-768 transmissions, however, standards have not yet been established for a preferred data-transmission format.

Unlike RZ data, NRZ data at 40 Gb/s does not have a 40-GHz frequency component. Clock recovery from 40-Gb/s NRZ data requires a nonlinear element in the front end of the CRU. This function is generally implemented digitally at rates to OC-192 using an XOR gate with one of its two inputs slightly delayed, or with flip-flops operating on rising and falling edges. Since XORs and flip-flops operating at 40 Gb/s data rates are not currently avail-



1. This block diagram shows a CRU based on the use of a high-Q bandpass filter.



Carrier: 622.08E+6 Hz
+ 0
-10
-20
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-80
-90
-100
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-120
-130
-140
-150
-160
-170
-180
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1M
10M
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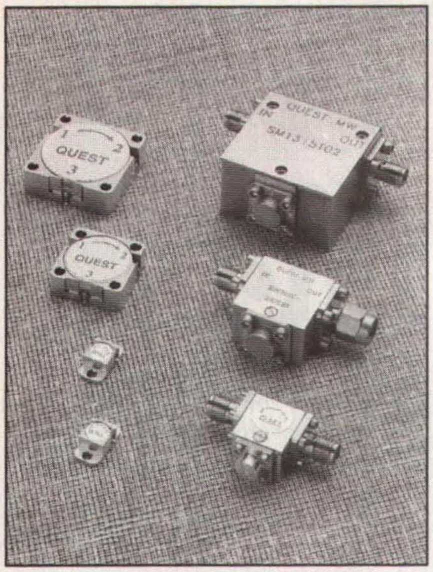

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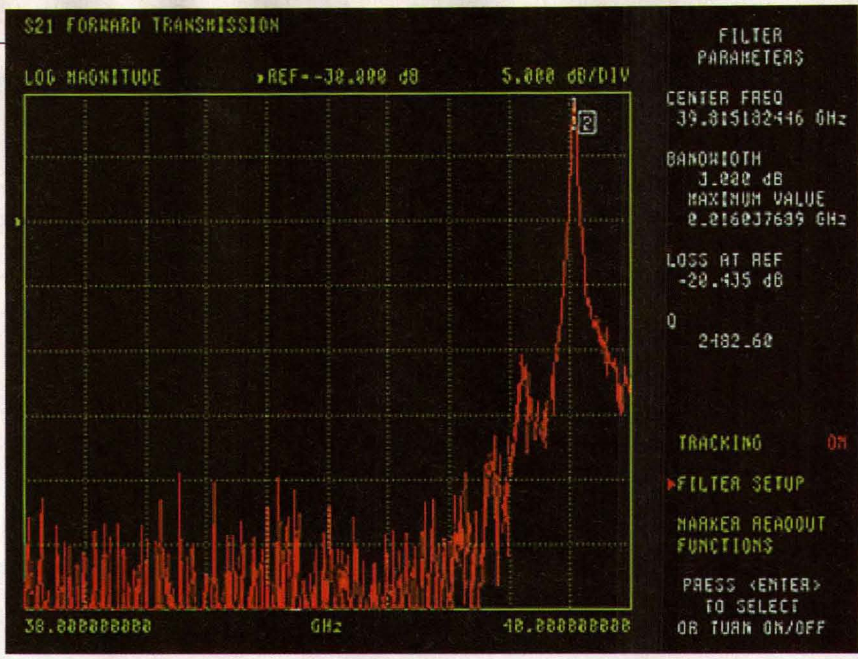
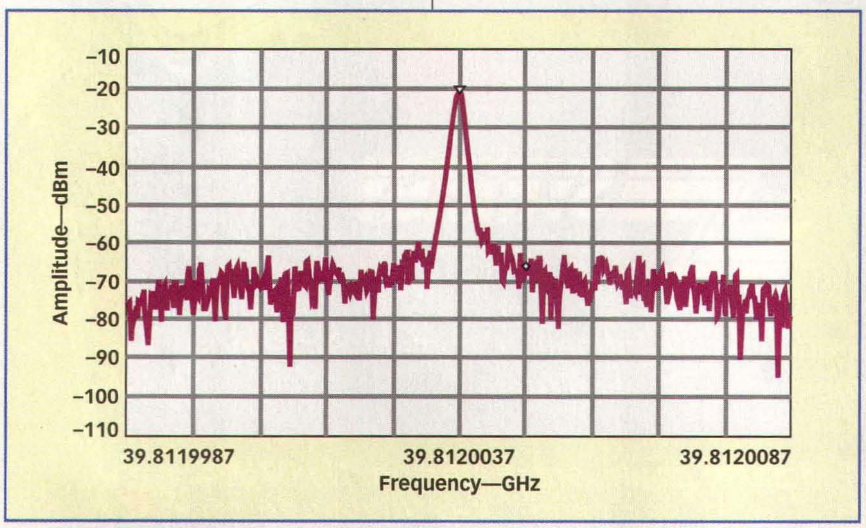


2. The response of the dielectric-resonator filter used in the CR-40 CRU was measured with a vector network analyzer (VNA).

able, CTI developed a circuit based on a wideband field-effect-transistor (FET) multiplier for its CR-40 CRU. A high-Q dielectric-resonator filter with a bandpass response centered at the clock frequency rejects the unwanted spectrum, leaving a low-jitter clock signal.

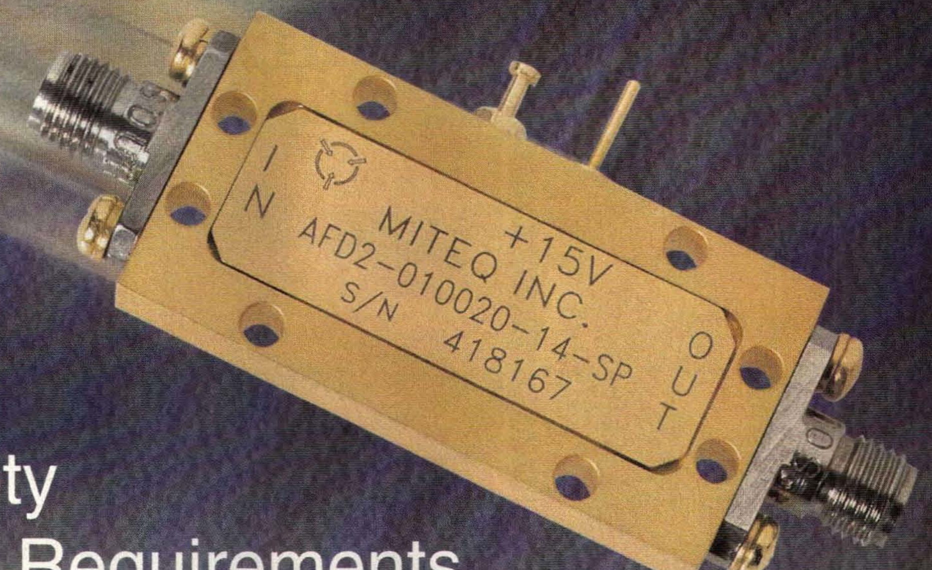
The Q of this filter must be sufficiently high for the clock signal to continue 'ringing' without considerable decay in amplitude and drift in phase during long periods when data transitions are absent. The bandwidth of the filter should be small enough to minimize jitter. The insertion loss should be low to reduce the number of amplifier stages needed to boost the clock signal's voltage to a useful level. Temperature-induced variations of the filter's group delay must be minimized for the clock phase to remain stable for all operating conditions. The filter must also have excellent broadband rejection to reduce unwanted spurious signals. Typical rejection of spurious signals in OC-768 applications must be better than 35 dB. Since most of the power of a 40-Gb/s NRZ data stream is concentrated from DC to 35 GHz, the filter should achieve high rejection over that range.

CTI uses the hybrid electromagnetic (EM) mode of a cylindrical dielectric resonator by placing the resonator in a specially designed cavity to enhance



3. The close-in spectrum of the CR-40's output clock signal was measured with a microwave spectrum analyzer.

Moderate & Octave Band Amplifiers



Amplifiers for a Variety of System Requirements

MODEL NUMBER	FREQ. (GHz)	GAIN (dB, Min.)	GAIN FLATNESS (±dB, Max.)	NOISE FIGURE (dB, Max.)	IN/OUT VSWR	POWER OUT (dBm, Min.)	CURRENT (mA, Typ.)
AFD2-010020-14-SP	1–2	20	1.50	1.4	2.0:1	+10	100
AFD3-010020-14-SP	1–2	34	1.25	1.4	2.0:1	+10	120
AFD3-022023-12-SP	2.2–2.3	30	0.50	1.2	1.5:1	+10	100
AFD3-023027-12-SP	2.3–2.7	30	0.50	1.2	1.5:1	+10	100
AFD3-027031-12-SP	2.7–3.1	30	0.50	1.2	1.5:1	+10	100
AFD3-031035-12-SP	3.1–3.5	30	0.50	1.2	1.5:1	+10	100
AFD3-037042-12-SP	3.7–4.2	30	0.50	1.2	1.5:1	+10	100
AFD3-040080-35-SP	4–8	24	1.25	3.5	2.0:1	+10	150
AFD3-020080-40-SP	2–8	23	1.50	4.0	2.0:1	+10	150
AFD3-040120-55-SP	4–12	18	1.50	5.5	2.0:1	+10	150
AFD3-080120-50-SP	8–12	18	1.25	5.0	2.0:1	+10	150
AFD1-010020-23P-SP	1–2	11	1.00	4.0	2.0:1	+23	275
AFD2-010020-23P-SP	1–2	25	1.50	3.5	2.0:1	+23	400
AFD3-020027-23P-SP	2.0–2.7	22	1.25	4.5	2.0:1	+23	350
AFD3-027031-23P-SP	2.7–3.1	22	1.25	4.5	2.0:1	+23	350
AFD3-031042-23P-SP	3.1–4.2	22	1.25	4.5	2.0:1	+23	350
AFD3-040080-23P-SP	4–8	20	1.25	5.5	2.0:1	+23	350
AFD3-020080-20P-SP	2–8	18	1.50	6.0	2.0:1	+20	350
AFD3-080120-20P-SP	8–12	15	1.50	6.5	2.0:1	+20	350
AFD3-040120-18P-SP	4–12	15	1.75	6.5	2.0:1	+18	350

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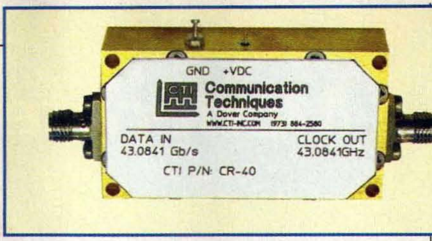
the loaded Q with low insertion loss. CTI's 40-Gb/s CR-40 CRU has a filter with a loaded Q of greater than 2000, an equivalent jitter transfer bandwidth of less than 12 MHz, and jitter generation of less than 15-mUI root mean square (RMS). In comparison, a filter with a loaded Q of 1000 or less, while able to recover a reasonably clean clock signal, would not be able to sustain the output clock signal when there are no bit transitions for more than a few 100-b periods. A filter with Q of greater than 3000, would provide superior jitter performance, but would suffer from excessive sensitivity to temperature variations. CTI has optimized the Q at approximately 2000 to maintain an optimum balance between jitter and frequency stability over temperature **(Fig. 2)**. At temperatures from 0 to +70°C, the shift in filter center frequency is less than 3 MHz.



4. The CR-40 CRU series includes 39.813-Gb/s, 42.656-Gb/s, and 43.0841-Gb/s models.

Particular attention was given to the design of the module's data-input section. The return loss of this port must be able to support a data signal with a rise time of a few picoseconds without significantly distorting the waveshape. The CR-40 unit can handle input data levels as low as 100-mV peak to peak and still provide a constant +1-VDC peak-to-peak clock voltage.

The CR-40 draws approximately 150-mA DC current from a +10-VDC supply. For a pseudorandom binary-sequence input pattern of 231-1, with a minimum input-data level of 100-mV peak to peak, the unit provides a clock-frequency output of +1-VDC peak to peak. Jitter generation is typically less than 15-mUI RMS, and the jitter-transfer bandwidth is less than 12 MHz. The typical phase noise of a 39.813-GHz recovered clock signal is −74 dBc/Hz offset 10 kHz from the carrier **(Fig. 3)**.

The input and output return loss at the clock frequency is typically better than 12 dB. The second harmonic is less than −20 dBc, and spurious signals are less than −40 dBc. The CR-40 series includes models for 39.813 Gb/s, 42.656 Gb/s, and 43.0841 Gb/s **(Fig. 4)**, and any other forward-error-correction (FEC) rates for OC-768. **Communication Techniques, Inc., 9 Whippany Rd., Whippany, NJ 07981; (973) 884-2580, FAX: (973) 887-6245, e-mail: skunasani@cti-inc.com, Internet: www.cti-inc.com.**

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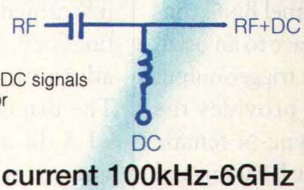

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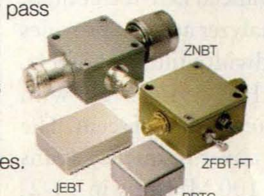

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▲ZFBT-6G	10-6000	0.15	0.6	1.0	32	40	30	1.13:1	79.95
▲ZFBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	50	1.13:1	79.95
▲ZFBT-6GW	0.1-6000	0.15	0.6	1.0	25	40	30	1.13:1	89.95
▲ZFBT-4R2G-FT	10-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	59.95
▲ZFBT-6G-FT	10-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-4R2GW-FT	0.1-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-6GW-FT	0.1-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	89.95
★ZNBT-60-1W	2.5-6000	0.2	0.6	1.6	75	45	35	1.35:1	82.95
■PBTC-1G	10-1000	0.15	0.3	0.3	27	33	30	1.10:1	25.95
■PBTC-3G	10-3000	0.15	0.3	1.0	27	30	35	1.60:1	35.95
■PBTC-1GW	0.1-1000	0.15	0.3	0.3	25	33	30	1.10:1	35.95
■PBTC-3GW	0.1-3000	0.15	0.3	1.0	25	30	35	1.60:1	46.95
•JEBT-4R2G	10-4200	0.15	0.6	0.6	32	40	40	-	39.95
•JEBT-6G	10-6000	0.15	0.7	1.3	32	40	40	-	59.95
•JEBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	40	-	59.95
•JEBT-6GW	0.1-6000	0.15	0.7	1.3	25	40	30	-	69.95

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F 164 Rev B

Adapter Converts Scope To 1-GHz Spectrum Analyzer

This low-cost half-rack instrument uses the display screen of any oscilloscope to show spectral displays from 10 MHz to 1 GHz across a 70-dB on-screen dynamic range.

JACK BROWNE
Publisher/Editor

Spectrum analyzers can carry a hefty price tag. But with the Model 7700 spectrum-analyzer adapter from Protek (Allendale, NJ), a low-cost, two-channel oscilloscope can be transformed into a 1-GHz spectrum analyzer for a fraction of the cost of a stand-alone analyzer. The compact adapter sends trigger signals and detected video signals to the two oscilloscope channels to create spectral displays with 1-kHz center-frequency resolution and 70-dB on-screen dynamic range.

The 7700 is a half-rack instrument that contains the RF, IF, and video-detection circuitry of an RF spectrum analyzer—everything except the display screen. Two front-panel BNC connectors provide the interface to an oscilloscope—one provides the trigger-output signal while the other provides the video-output signal. Type-N female connectors are used for the RF input and output connections for the spectrum-analyzer adapter.

Based on advanced DSP techniques, the spectrum-analyzer adapter provides resolution-bandwidth filters of 3 kHz, 30 kHz, 220 kHz, and 4 MHz with specified accuracy of ±15 percent. The instrument can cover frequency spans of 2 kHz/div to 100 MHz/div in a 1-2-5 sequence, and also offers zero-span measurement capability. The 7700 operates at a fixed video bandwidth of 1 kHz. The frequency stability, based on an 80-MHz reference source, is ±10 PPM. The unit can also perform swept measurements with 40-Hz sweep resolution at 2 kHz/div.

With a low-cost oscilloscope, the spectrum-analyzer adapter can display 500 points of horizontal resolution. The reference level (the highest-amplitude signal displayed) can be set from −30 to +20 dBm, while the 7700 handles a full input range of −100 to +20 dBm. The instrument features attenuation settings of 0, 10, 20, 30, 40, and 50 dB for adjusting the levels of input signals. The displayed amplitude accuracy is ±1.5 dB at 80-MHz calibration frequency, while the amplitude linearity is ±1.5 dB over a 70-dB range. The amplitude flatness is ±1.5 dB for a display of 10 MHz/div. is ±1.5 dB for a display of 10 MHz/div.

Despite its low $1400.00 price, the 7700 adapter is a fully synthesized spectrum-analyzer front end that is capable of typical average noise levels of −140 dBm/Hz and typical phase noise of −87 dBc/Hz offset 10 kHz from the carrier. **Protek, 40 Boroline Rd., Allendale, NJ 07401; (201) 760-9898, FAX: (201) 760-9888, e-mail: hcprotek@hcprotek.com, Internet: www.hcprotek.com.**

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2WAY-90°	4	1.00-4.20
2WAY-180°	2	1.00-2.49
3WAY	41	0.50-4.20
4WAY	83	0.47-8.40
5WAY	6	0.80-1.98
6WAY	25	0.80-5.00
7WAY	4	1.00-1.99
8WAY	62	0.50-8.40
9WAY	3	0.80-4.80
10WAY	11	0.75-2.40
12WAY	9	0.50-4.20
14WAY	1	0.90-0.99
16WAY	28	0.47-4.80
32WAY	1	0.95-1.75

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Ridge Waveguides and Passive Microwave Components

JOSEPH HELSZAJN

RIDGE WAVEGUIDE CAN be used to form a variety of microwave components, including filters with low passband loss and high out-of-band rejection. Based on rectangular waveguide with one or more metal ridges, ridge waveguide exhibit wide separation between dominant and first-order modes. Since they are frequently used in commercial electronics and communications devices, ridge waveguides have become well-established.

Ridge Waveguides and Passive Microwave Components by Professor Joseph Helszajn provides the reader with closed-form and finite-element calculations of the propagation constant, attenuation and mode spectrum for the ridge waveguide.

Chapters one through three offer an introduction to ridge waveguide and discussions of propagation and impedance in rectangular and ridge waveguides using the transverse-resonance method. The wave equation is covered, as well as ridge-waveguide cut-off space and circular polarization in rectangular waveguides. Chapters four through six offer discourses on fields, propagation, and attenuation in double-ridge waveguides; impedance of double-ridge waveguides using the finite-element method; and characterization of single-ridge waveguides using the finite-element method.

Chapters seven through nine offer commentary on propagation constant and impedance of dielectric-loaded ridge waveguides using a hybrid finite-element solver, circular polarization in ridge and dielectric-loaded ridge waveguides, and quadruple-ridge waveguides. Chapters 10 through 12 feature Faraday rotation in gyromagnetic quadruple-ridge waveguides, characterization of discontinuity effects in single-ridge waveguides, and ridge-crossguide directional couplers.

Chapters 13 through 15 provide information on directly coupled filter circuits using immittance inverters, ridge-waveguide filter designs using the mode-matching method, and nonreciprocal ridge isolators and phase shifters. Chapters 16 through 18 offer insight into finline waveguides, inverted-turnstile finline-junction circulators, and semi-tracking ridge circulators. Chapter 19 concludes the volume by highlighting variational calculus, functionals, and the Rayleigh-Ritz procedure.

Ridge Waveguides and Passive Microwave Components combines much of Helszajn's work, allowing the reader to bypass traditional research papers and directly access the information. (2000, 327 pp., hardcover, ISBN: 0-85296-794-2, $98.00.) **The Institute of Electrical Engineers, Michael Faraday House, 6 Hills Way, Stevenage, Herts SG1 2AY, United Kingdom; +44 (0)1438 313311, FAX: +44 (0)1438 313465, Internet: www.iee.org.uk/TheIEE/Locations/MFH.**

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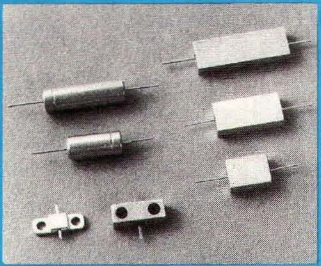

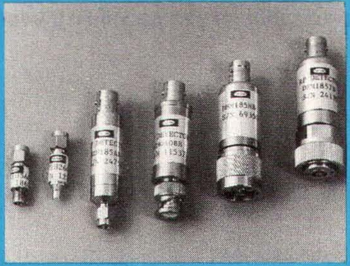

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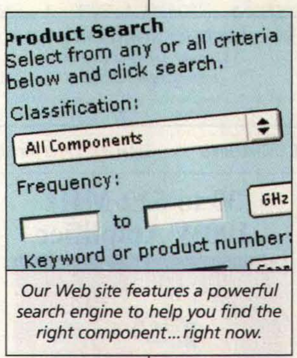

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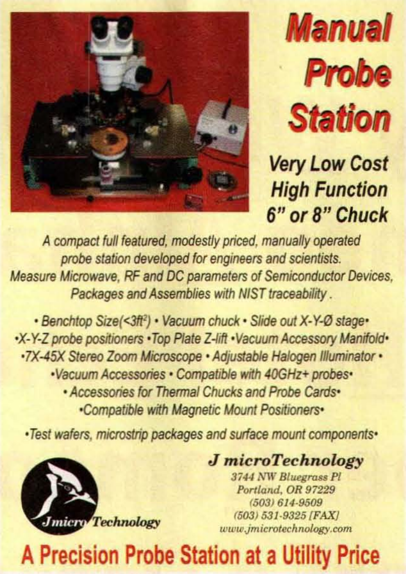

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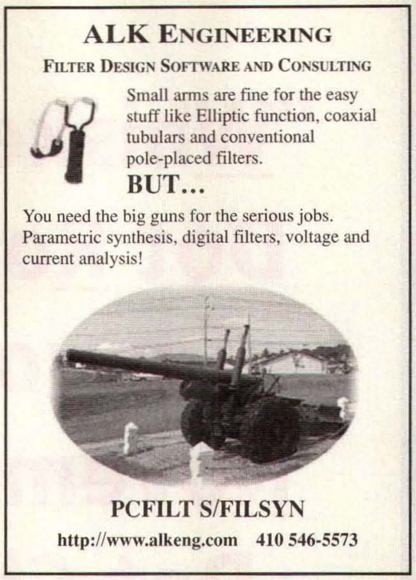

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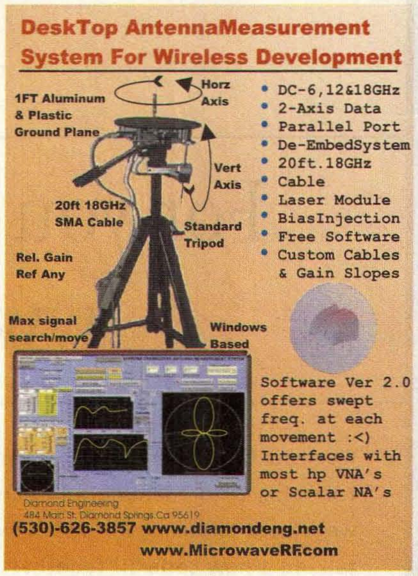

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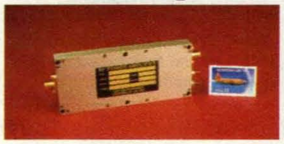

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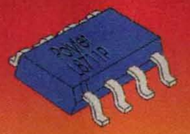

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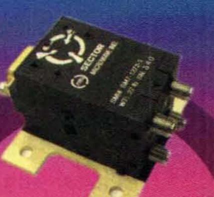

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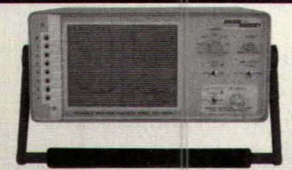

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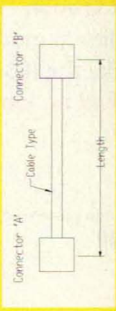

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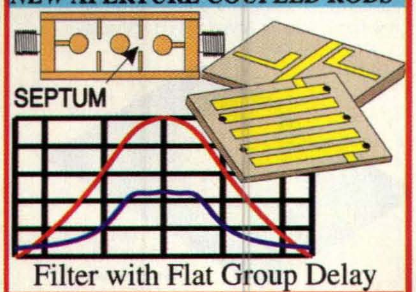

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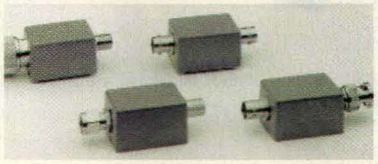

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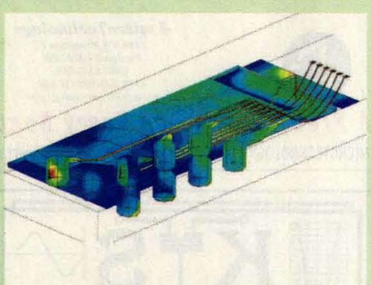

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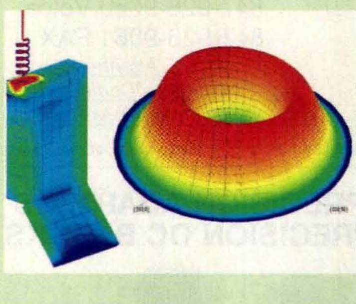

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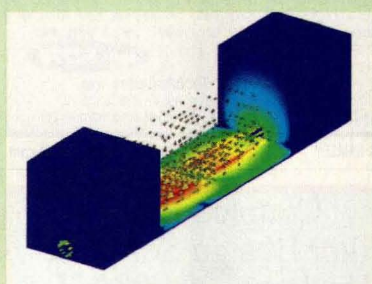
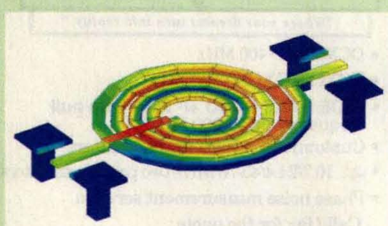
The near field and Poynting vector display on a packaged PCB structure with vias and connectors



IE3D modeling of a circular spiral inductor with thick traces and vias



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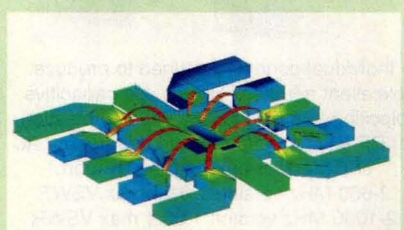
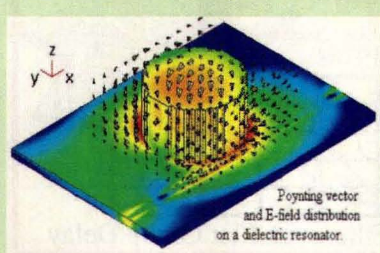


FIDELITY modeling of a cylindrical dielectric resonator and the Poynting vector display



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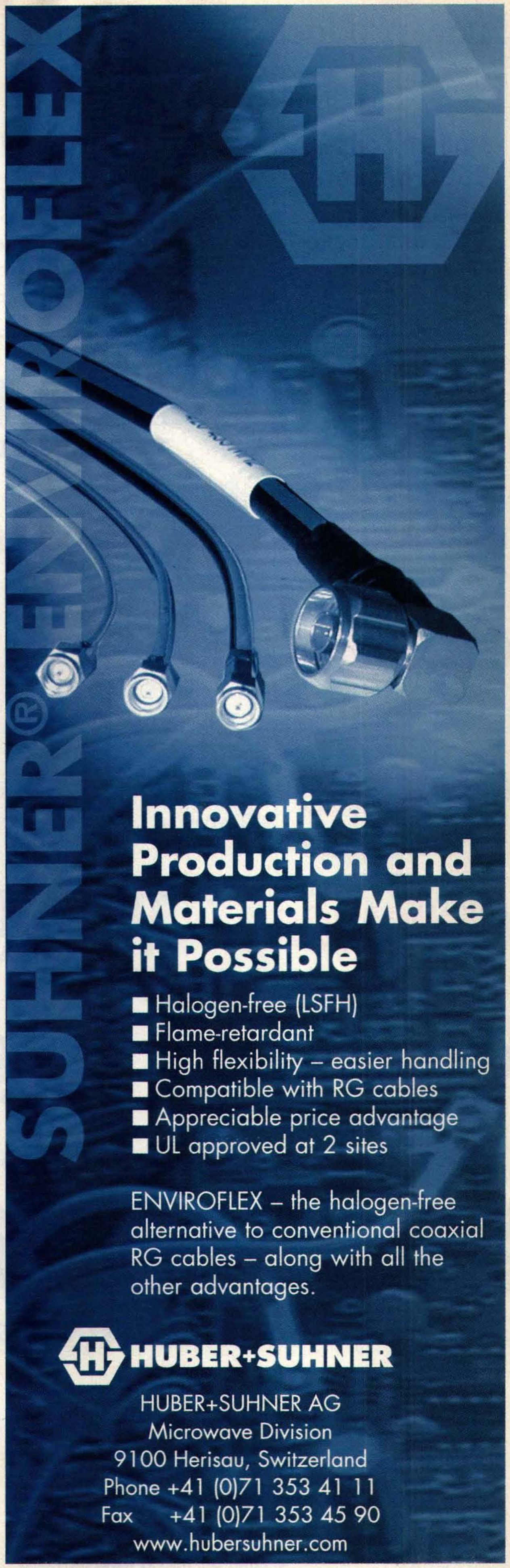

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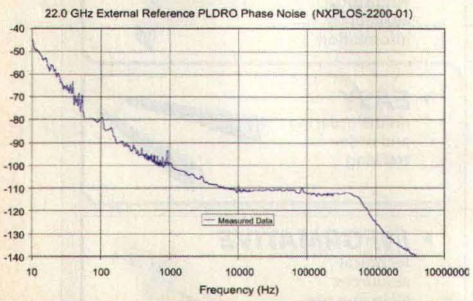

Phase Noise at 22 GHz (Typical)

100 Hz	**- 80 dBc/Hz**
1 KHz	**-100 dBc/Hz**
10 KHz	**-110 dBc/Hz**
100 KHz	**-112 dBc/Hz**
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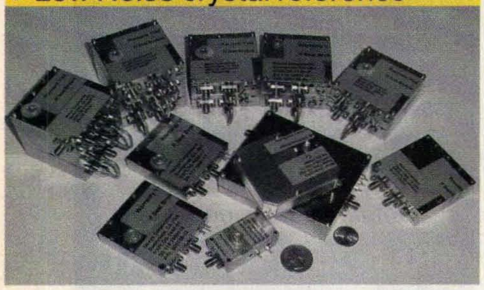

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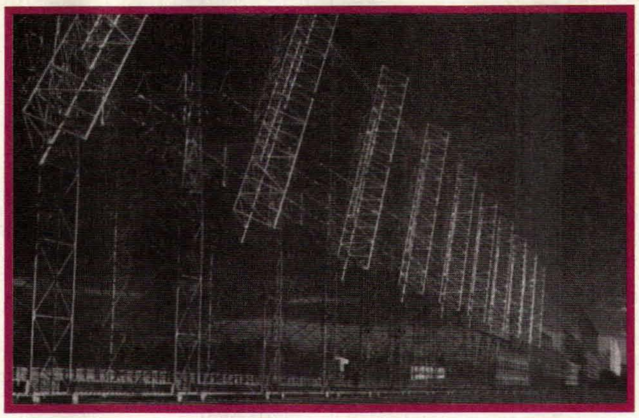

ALMOST 12 YEARS AGO, a news story reported the US Air Force finally accepting installation of the East Coast over-the-horizon backscatter (OTH-B) radar system from General Electric some 15 years after the project had begun.

next month

Microwaves & RF May Editorial Preview

Issue Theme: Radar & Antennas/ MTT-S Preview

News

The May issue will preview the 2002 IEEE International Microwave Theory & Techniques Symposium (MTT-S) scheduled for June 2-7 in the Seattle Convention Center. The preview section will provide highlights of hundreds of technical presentations, workshops, and panel sessions. It will also offer brief looks at some of the latest hardware, software, and test equipment to be launched in the MTT-S exhibition hall. In addition, the News section will offer a Crosstalk interview with Mike Snyder, President of MCE/KDI Integrated Products (Whippany, NJ). A Special Report will summarize the state of some of the most significant emerging technologies to impact microwave designers, including MEMS and SiGe semiconductors.

Design Features

The lead technical article in May offers a first look at the latest version of a popular planar electromagnetic (EM) simulation program. Using an enhanced interpolation method known as adaptive band synthesis, this powerful modeling tool features one to two orders increase in processing speed for multifrequency analysis compared to earlier versions of the program. Additional technical articles examine a low-profile omnidirectional base-station antenna with dual polarization and a continuation of the multipart article series on short-range radio design.

Product Technology

May's product highlights include a review of the newest version of an integrated circuit/system software simulation suite for personal computers. Additional Product Technology stories evaluate a line of tiny couplers and power dividers based on multilayer circuit technology, a PCM/FM demodulator for improved detection efficiency in airborne telemetry systems, and a line of V-band components for unlicensed communications systems operating at 60 GHz.

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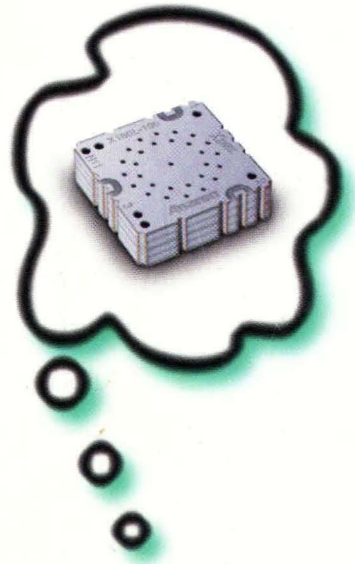

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